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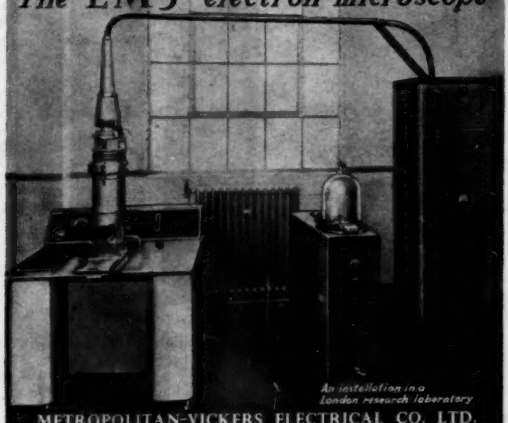

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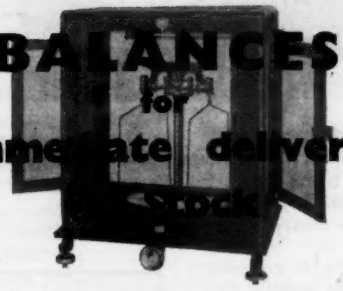

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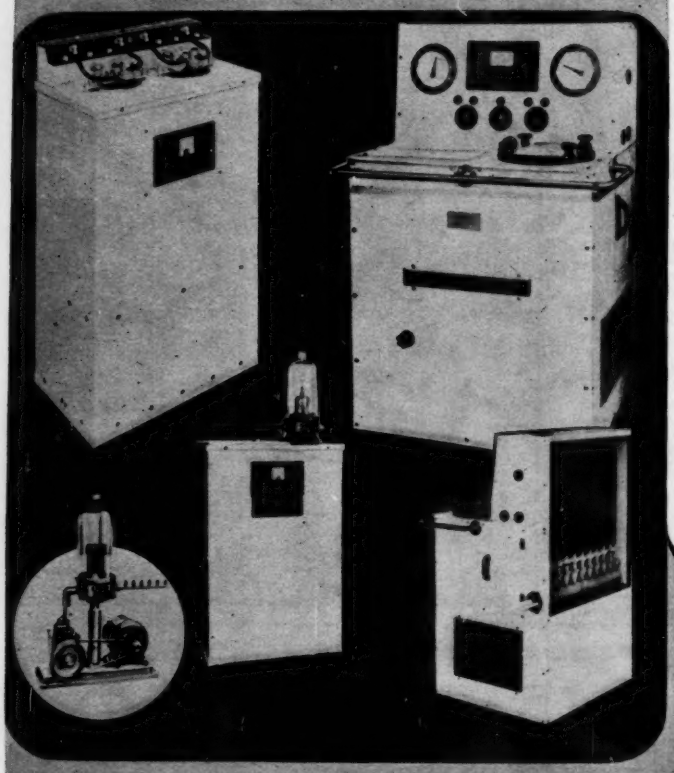

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NATURE

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LEADERSHIP, POWER AND RESPONSIBILITY

IN an address "Power and Responsibility", delivered to the Faculty of Medicine at the University of Sheffield last October, and which has since been published in *The Lancet* (262, 61; 1952), Sir Francis Fraser emphasized a point in the changing position of the universities which is commonly overlooked in discussions on university education, and particularly on the function of the university in the modern community. Even with the wider entrance to the universities and the increased number of students, the undergraduate is a privileged member of his community. However imperfect methods of selection may be, an undergraduate, from the outset, Sir Francis reminds us, has been selected as worthy of receiving an education of a higher standard than the rest of his contemporaries, and he should emerge as a graduate with something which the others do not possess. His mind has been opened to appreciate, at least within some one discipline, what is true, good and beautiful, and to reject the false, the bad and the ugly; he has been shown the way of advance and hope for the future.

Such privileges and the gifts they confer carry responsibilities. The graduate owes something to the community for his privilege and opportunity, and should use the gifts and skills he has acquired, in whatever field, for the good of the community. In this sense, at least, a university education is education for leadership. The universities train, as they have always done, men and women for positions of responsibility requiring leadership and devotion to the service of their fellows. The new feature is only the wider range of studies over which such training is provided, and the increasingly onerous demands which some of the new disciplines such as science and medicine make. It is becoming more and more difficult to find room in the university curriculum for the consideration of those questions which most effectively bring the student to face problems of human values and which train him in the wise and imaginative use of the knowledge he acquires. That is one factor which has stimulated the discussion in recent years on the content of university education, including higher technological education, and how the dangers of specialization can be minimized or avoided. Sir Francis does not enter on the question as to which professional disciplines are proper subjects of a university education. Some he recognizes as appropriate, and among these he includes, for reasons given, medicine itself. His advocacy of the association of clinical science with the universities is of interest in relation to recent suggestions for the dissociation from the universities of certain types of higher technological studies and research, based on analogy with clinical research.

But there is a further very significant factor to which Sir Francis directs attention. Among the great social changes of our time, opportunity has been re-distributed, and education and money have been spread more evenly; and with education and

money goes power. Power, Sir Francis observes, is no longer confined to those who by tradition and education have been trained to use it wisely and unselfishly. That tradition may even be less widespread among those now entering the universities; but, whatever the universities themselves can do to repair any such deficiency, the danger of our time is that, individually and collectively, many who now possess the power to determine the conditions of their own lives and the lives of their descendants are confused and do not know how to use it. "The progress of science has placed powerful forces at man's disposal and has outstripped man's knowledge of how to use, and, above all, how to control them."

Sir Francis quotes Mr. Winston Churchill's words of twenty years ago: "The busy hands of the scientists are already fumbling with the keys of all the chambers hitherto forbidden to mankind. Without an equal growth of Mercy, Pity, Peace and Love, science herself may destroy all that makes human life majestic and tolerable." Whether the mantle of leadership falls on the graduate by the nature of the appointment he takes up or not, all graduates, Sir Francis urges, have the duty of helping and serving their fellow-men in facing and solving these problems, at least by the example of their work and life. They are called upon, as Lord Bryce reminded an earlier generation, to preserve the academic spirit throughout their business or professional careers, furnishing skilled leaders in political and social movements, and forming the public opinion of the whole community by which nation and State are ruled. What the community needs, and the universities should seek to provide, are men and women of harmonious and well-rounded intellect and character, of personality in whom all faculties have been cultivated and brought as nearly as may be to a symmetrical completeness. Such men and women will possess not merely learning and intellectual power, but also wisdom and the aptitudes which find their scope in practical life, and enable men and women to work usefully with others and to exercise a wholesome influence in their community.

The linking of power and responsibility in this way in Sir Francis Fraser's lecture finds a significant counterpart in one of the most eloquent and moving of the seven Reith Lectures on "Power and the State" which Lord Radcliffe delivered in November and December. Lord Radcliffe's lectures were critical rather than an original contribution to thought. He advanced no new political philosophy of his own; but his careful review of political precepts and practice may none the less stimulate that creative thinking which is essential if man is to shape the political institutions he has inherited to meet the needs of a new situation. By challenging opinions and doctrines that are too readily accepted without question, Lord Radcliffe may well have made an important contribution towards the solution of two particular problems of power and authority in the modern State which are of especial importance at present, namely, the nationalized industries, and national security measures. The question of the nationalized industries and their control is essentially one of power—of ensuring that power is not abused and that it is exercised in full response to the desires of the community in whose service that power is designed to be used. The question of security, particularly in regard to atomic energy, is likewise a matter of the responsible exercise of power, though more at the level of the individual; it is not a matter simply of preventing the abuse of power, but also of loyalty and authority—of securing the assent and co-operation of those who possess specialized knowledge or skill which could be used against the interests of the community. Lord Radcliffe's forthright challenge in his last two lectures to Lord Acton's aphorism that "Power tends to corrupt, and absolute power corrupts absolutely" may well help towards the clear thinking which will be necessary to give us an adequate answer to both these contemporary questions.

Lord Radcliffe does not himself believe the aphorism, for he thinks that most men are the better for having some authority; and that it ignores the vital questions, what really prevents men from abusing their authority, and what is it, if it is not force, that leads men to give obedience to authority? In seeking an answer to the second question, we undoubtedly come near answering the question of leadership in the modern State, and certainly there is much in these lectures that throws light on the problem of education for leadership. That is notably true of the fifth lecture, on British rule in India, in which Lord Radcliffe fully justified his scepticism of Acton's dogma. The administrative achievement of the two generations of Englishmen who in the first half of the nineteenth century laboured to bring order and justice into India, which Lord Radcliffe reviewed in that lecture, stands, as he rightly said, as a classic example of how men really respond to the stimulus of great authority. Those men exercised absolute power, and their record gives the lie to the belief that power must always lead to selfish use in the pride of its possession. That record might well, too, make us pause to reflect that the real danger lies not so much in absolute as in irresponsible power, and that we should consider more carefully those conditions in the world to-day which among rulers and ruled alike weaken the sense of responsibility. Lord Radcliffe himself, in a subsequent lecture, pertinently recalled a group of writers, contemporaries of Munro and the Lawrences, who, against Victorian reliance upon political organization, contended—with Plato—that the secret of government is to find the best men and to trust them to rule.

That doctrine is not refuted because it gives no answer to the vital question of how to find the best men. Each generation and each age has to work out that problem for itself, as we are increasingly conscious. When Lord Radcliffe comments that the success of the whole casual system by which those Civil servants in India were selected is eloquent of the fine material that could be picked, as it were, almost at random, he reminds us of Whitehead's dictum that a great society throws up the leaders it needs for the occasion. Lord Radcliffe does not see

how a country that is worth living in can prosper without a reverence for its purpose, and his final words are, not to go against the best light that we have, to take care that our light be not darkness, and to think it possible that we may be mistaken. This may well make us wonder whether deficiencies in leadership to-day are not connected with the careless repudiation of values, the reckless pursuit of uniformity and reliance upon institutions and forms of organization rather than men.

What Sir John Cockcroft said at the seventh Present Question Conference last August* on freedom and responsibility in science points the same way. He thinks that, even within the atomic-energy field in an establishment such as Harwell, a reasonable solution has been found which provides the essential freedom for scientific work. On the larger issue of security as it affects freedom of movement and discussion, he maintains that scientific men have shown a full sense of responsibility. Although there are a few notorious exceptions which make it desirable to re-examine from time to time the adequacy of our institutions from the security point of view, so far it can be held that in Great Britain we have succeeded in maintaining security without seriously endangering either the existence of a free society or the conditions of scientific and other creative work.

The recent books of Prof. Walter Gellhorn and Mr. Alan Barth and others have shown how grave a threat to science and to free institutions stems from the methods of the Un-American Activities Committee and the Internal Security Sub-committee of Congress in the United States, particularly under the Internal Security Act, 1950, which was carried against the veto of the President. The dangers of formal procedure, especially without due process of law, are amply displayed by Prof. Gellhorn and Mr. Barth. Though the new security checks in Britain on Government staff on exceptionally secret work, especially work involving access to secret information about atomic energy, have doubtless been prompted by the Prime Minister's anxiety to restore the freedom of exchange of information on atomic research between the United States and Britain that existed during the Second World War, the Government has wisely refrained from following American practice. The special inquiries to be made about those holding or applying for such posts are administrative rather than formal. Details of the proposed procedure are being discussed with the staff interests concerned, and there is no question of the political pressure and prejudice which have had such unfortunate repercussions in the United States playing any part. None the less, the fact that new measures have had to be considered should remind the scientific men as well as others that the problem of secrecy is as yet far from being solved. It is only one aspect, though an important one, of the problem of power and the State. We can agree with Lord Radcliffe that men are more important than institutions, and that the first task is to seek the men who can be trusted to exercise power with wisdom and responsibility. But prudence would also counsel us so to shape or recast our institutions that they will better serve our ends, and offer the least temptation or opportunity for mischief to any less scrupulous individuals who may find themselves with power and authority.

* Question : a Journal. Vol. 4, No. 1 : Freedom and Responsibility. By H. Westmann, Dr. J. H. Oldham, Sir John Cockcroft, J. F. Wolfenden and Emile de Groot. Pp. 104. (London : Hammond, Hammond and Co., Ltd., 1951.) 2*s.* 6*d.*

THE ORIGIN OF LIFE

The Physical Basis of Life

By Prof. J. D. Bernal. Pp. 80. (London : Routledge and Kegan Paul, Ltd., 1951.) 6*s.* net.

THIS short book consists, in the main, of the thirty-first Guthrie Lecture of the Physical Society, which was given by Prof. J. D. Bernal in 1947. It has already been published in the *Proceedings* for 1949 of that Society, but is offered here to a wider, and perhaps particularly to a biological, audience ; and it is embellished with a number of critical comments, mainly by Mr. N. W. Pirie, to which the author replies.

The Lecture is undoubtedly an important contribution to speculative biology. Bernal attempts to formulate a series of hypotheses which will enable us to imagine how living material may have been formed from non-living in the early stages of the world's history. There is, of course, extremely little firmly established fact on which to build such theories ; no such process of origin can be observed at the present day, or even approximated to in the laboratory. A plausible argument must rest on three main pillars : a deep insight into the essential nature of the living processes the origin of which is being sought, a thorough grasp of the types of physico-chemical mechanism which can be appealed to, and finally an understanding of the geochemical conditions which are likely to have existed at the time in question. There are few indeed better qualified than Bernal to deal with these diverse fields of knowledge, and to weave out of the separate threads some sort of garment in which we can clothe our ignorance.

Bernal points out the difficulty of giving any precise definition of life, by which one could in all cases discriminate sharply between the living and the not-living. He glances at the interesting, but extremely abstract, question of the philosophical concept of life, and suggests that if one were to look for a definition which would cover even forms of life at present unknown, which might exist elsewhere in the universe, one would have to adopt criteria so general that they would include nebulæ, on one hand, and flames, on the other, as living things. He rapidly draws back, however, to a more empirical and more matter-of-fact approach, and suggests that the "basic chemical problem of all vital transformation is the achievement of chemical changes in an isothermal medium, by which large amounts of energy can be made use of in the small steps which alone are permissible in such a system". In living things at the present day, such processes are fundamentally based on the properties of enzymes of a protein nature. One of the most original of Bernal's suggestions is that clay particles have properties which would enable them to act as very inefficient "enzymes", preferentially adsorbing certain moderately complex organic molecules, at a period before

the synthesis of protein had occurred. In this way "we could imagine that simpler molecular compounds could be made to undergo complex polymerisation, polymerisation to such an extent that the macromolecules produced might be able to persist in a colloidal form even without clay, and become catalysts or, as we should now call them, enzymes in their turn".

From this the reader passes on to an interesting discussion, to which Pirie adds an important point, about the arising of coloured substances, and thus to the evolution of the photosynthetic mechanism. The Lecture concludes with some remarks about some of the characteristics of living cells, particularly the process of cell division.

There is one aspect of the matter to which Bernal makes scarcely any allusion: that is, the provision of a mechanism ensuring genetic continuity combined with the possibility of evolutionary change. At some stage after Bernal's postulated "establishment of a chain of reactions where complex molecules can be fed in at one end and simple ones liberated at the other, with a net energy gain", there must be produced a mechanism by which such a living particle can not only reproduce identically (for example, by fission), but also reproduce in a variant form which is capable of perpetuating its new character. Such a mechanism has, in fact, been provided by the evolution of the gene; we miss the doubtless very stimulating suggestions Bernal might have made as to how it came about. C. H. Waddington

MANAGEMENT OF LABORATORY ANIMALS

The Care and Breeding of Laboratory Animals

By Edmond J. Farris (editor) and a staff of 15 Contributors. Pp. xvi+515. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 64*s*. net.

THE publication of this book is yet another indication of the growing concern with the care and management of laboratory animals. This tendency is to be welcomed whole-heartedly. In the past, it has been common for research involving the use of animals to be held up by the lack of suitable stocks, or ruined by the poor quality of those used. In contrast, the necessity for adequate supplies of first-class laboratory animals is now becoming generally recognized. The early protagonists of the improvement of laboratory animals were nowhere more in evidence than at the Wistar Institute (hence the Wistar rat), and it is appropriate, therefore, that a book as valuable as the one under review should have been produced under the editorship of the present executive director of the Institute.

Most of the book, of course, is devoted to laboratory mammals; but there are chapters on domestic fowl, reptiles, amphibians, fishes and *Drosophila*. The mammalian section comprises separate chapters on the monkey, rat, mouse, guinea pig, Syrian hamster, rabbit, dog, cat, ferret and opossum. This layout of the book leaves something to be desired, and one could wish that information had been given about some of the lesser-used species. The domestic fowl, for example, is very far from being the only bird used in the laboratory. In the same way, the list of mammals is by no means exhaustive, omitting, as it does, old friends like *Peromyscus* and new-comers such as the cotton rat and the vole. Moreover, the editor, like other editors, seems to have been plagued by a tendency on the part of the contributors to write at very different levels of detail. Thus the Syrian hamster, comparatively new to the laboratory, is given 30 pages of text, while Dr. Farris allows himself only the same space to deal with the rat, and Dr. Ibsen deals with the guinea pig in 17 pages. This disproportion is the more remarkable because the hamster has a lowly position in the table of frequency of use of different species given in Dr. Farris's preface. This table contains unusual information and is worth quoting. In 1,500 investigations reported at the annual meetings of the American Association of Anatomists, the American Society of Zoologists and the Federation of American Societies for Experimental Biology in 1947, the order of frequency of mammals used was as follows:

Man	334	Monkey	41
Rat	317	Cow	25
Dog.	258	Hamster	9
Rabbit	110	Sheep	9
Mouse	108	Pig	8
Cat	81	Horse	4
Guinea pig	49	Others	16

The high place occupied by man and the dog in this list is rather remarkable, as is the low one occupied by the guinea pig. It would be most interesting to compare this list with a similar one for investigations carried out in Great Britain.

With these qualifications, it may be emphasized that the book, over the ground and at the level it covers, is good, and nearly all the individual contributions are interesting and informative. No more acceptable writer on monkeys could be found than Dr. G. van Wagenen, and if her views seem sometimes to be anthropocentric and some of her methods traditional, those who have seen her Rhesus colony at New Haven can justifiably maintain that the proof of the method is in the monkey. It is good also to see another exponent of the personal touch, Dr. L. C. Strong, contributing the chapter on the care of mice. The Strong mouse colony at New Haven is perhaps the most famous in the world, and its success is founded, not on elaborate equipment, but on the human element. In these circumstances, it is no criticism to say that Dr. Strong, like Dr. van Wagenen, tends to describe methods in use in his own colony rather than to discuss the principles involved and the pros and cons of different methods. The chapter on the rat is full of useful information; by contrast, the chapter on guinea pigs cannot be regarded as an adequate account of this much-used laboratory animal. A curious example of the unevenness of the writing of this book is provided by the fact that the breeding of guinea pigs, which are bred in scores of thousands in laboratories, is dealt with in 1½ pages, while the greater part of the chapter on cats is devoted to an excellent and profusely illustrated account of the physiology and morphology of reproduction in a species which is rarely bred in the laboratory. The chapter on the ferret, by Dr. T. H. Bissonnette, who was introduced to that useful but awkward laboratory animal in F. H. A. Marshall's laboratory in Cambridge, England, is an indication of the increasing use being made of this species in the United States.

This review would not be complete without a word of congratulation to the authors of the chapters on reptiles and fish, Dr. C. H. Pope and Dr. M. Gordon, respectively. These two chapters constitute the best

accounts known to me of reptiles and fish as general laboratory animals. It is refreshing to see turtles listed among laboratory animals, even though the word is found to include tortoises. There is also an apt reminder that turtles go back to the Triassic age, have changed little in the 175,000,000 years of their history, and may not be very adaptable to laboratory conditions.

No doubt a second edition of this book will be called for in the near future. If Dr. Farris then finds it possible to include a chapter on general matters affecting the animal house, especially the training of laboratory technicians, to even up the writing of his contributors, and to include something on the less-used species, then he will have produced a very good book indeed.

A. S. PARKES

A CLASSIC OF CAMBRIDGE ARCHÆOLOGY

The Archæology of the Cambridge Region

A Topographical Study of the Bronze, Early Iron, Roman and Anglo-Saxon Ages, with an Introductory Note on the Neolithic Age. By Dr. Cyril Fox. Re-issued with Appendix IV. Pp. xxv+360+A24. (Cambridge: At the University Press, 1948.) 37*s.* 6*d.* net.

THE reprinting of a standard work after a quarter of a century is a tribute of which any author might feel proud, more especially when his subject is one developing so rapidly as prehistoric archæology. The main reason for the vitality of this book is the abiding interest of its main theme—the changing pattern of human settlement of a definite region from the New Stone to the Anglo-Saxon Age. An additional and local reason why the book is so much used in Cambridge teaching is that so large a proportion of the material evidence is housed in the University Museum of Archæology and Anthropology, which has recently been further enriched by the accession of the Braybrooke (Neville) collection from Audley End. Far beyond Cambridge, though, the book has long been recognized as an outstanding essay in archæological method, the message of which is still very far from being exhausted.

Inevitably the book has proved a special spur to research within its own region, and this has inevitably rendered it in some respects out of date. All the greater welcome must be accorded, therefore, to the inclusion, as an appendix to the present reprint, of Sir Cyril Fred Fox's "Reflections" contributed to the *Cambridge Historical Journal* (**9**, No. 1; 1947), in which generous references are made to the work of his successors.

The effect of the introduction of the modern scientific method of pollen analysis on our appreciation of the early settlement of the region is particularly interesting to note. Writing in 1923, it was almost inevitable that Fox should have interpreted the restriction of early settlement to the lighter, better-drained soils in terms of the absence of forest, since no means were available at that time for testing the long-accepted dogma of the incompatibility of forests and early man. Ironically enough, it was in the northern part of the Cambridge region that the Fenland Research Committee first succeeded in establishing a systematic correlation between the history of vegetation and that of human settlement in the post-glacial period of England; and it was by studying the muds of Hockham Mere that Dr. H. Godwin was able to demonstrate the forested character of the Breckland itself and the initiation of clearance by the earliest neolithic occupants of the area.

Yet, though as Sir Cyril concedes in his "Reflections" we no longer link the settlement of lighter soils with the absence of forest cover, the demonstration that these were, in fact, occupied before those more difficult to cultivate remains one of his great achievements. 'Fox's theorem', as it has sometimes been termed, has been found to apply to many regions in lowland Britain, and the gradual change in land-occupation implied by the shift to heavier soils has led to a great advance in our understanding of the economic life of the prehistoric and early historic past.

In conclusion it is perhaps worth underlining Sir Cyril's wry comment in his "Reflections" that, despite the influence exerted by his book on other students, "it remains true that in important respects . . . *The Archæology of the Cambridge Region* has had, in twenty-five years, no successor". The availability of revolutionary new techniques of scientific research, which makes it practicable to study successive phases of early settlement in their real as distinct from their hypothetical or even legendary setting, only underlines the challenge. The co-ordination of human and natural history is of the utmost value at the highest levels of education—and one is thinking here as much of university teaching staffs as of undergraduates and of research as well as of formal teaching. A particularly fine example of what can be done is described in Dr. Therkel Mathiassen's description in his "Studier over Vestjyllands Oldtidsbebyggelse" (Copenhagen, 1948: English summary) of a survey of some 1,260 sq. km. of north-west Jutland organized by the National Museum of Denmark between 1942 and 1945 (for a review, see *Proc. Prehistoric Soc.*, 196; 1950).

British archæology has in the past been too much preoccupied with pursuing the Continental affinities of 'cultures' and all too little concerned with the character of settlement and mode of life of continuing generations of our early forbears in the several regions of Britain. Sir Cyril Fox and his followers at Cambridge have pointed the way, and signs are not lacking that some of the newer university centres in particular are preparing to answer Sir Cyril's challenge.

GRAHAME CLARK

COSMIC RAYS

Cosmic Rays

By Prof. Louis Leprince-Ringuet. Translated from the French by Fay Ajzenberg. (Prentice-Hall Physics Series.) Pp. xii+290. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1950.) 30*s.* net.

IN 1939 work on cosmic rays was accessible only in original papers, but there is now a number of books on the subject ranging from frankly popular accounts through introductory text-books for students, to summarizing handbooks which are tools of the research worker. It is rather difficult to place this book in relation to these categories.

Prof. L. Leprince-Ringuet, who is a distinguished French worker in cosmic rays, wrote the book in 1945, and it has recently been revised and translated for an American public. It now includes work done in 1950 and is therefore about as up to date as publishing conditions allow. No major discovery has, in fact, been missed—the book deals with the discovery of cosmic-ray particles about a thousand times as

massive as the electron, with the occurrence of heavy nuclei in the rays at the top of the atmosphere, and with the Fermi theory of the origin of cosmic rays by the acceleration of particles in moving galactic magnetic fields. Of course, these discoveries have matured considerably in the intervening year. The book lays its emphasis on experimental methods and their immediate results, and this emphasis is strengthened by a copious and well-produced collection of photographs of apparatus and of cosmic-ray phenomena in cloud chambers and photographic emulsions. These photographs are admirable and make the book a pleasure to look through. But it is not clear who can use the book with advantage—parts of it have a popular appeal, and indeed I suspect that some topics, like the use of manned stratospheric balloons, have earned their place by their spectacular rather than their scientific value.

However, the treatment is too detailed and its arrangement too confusing for the general reader. The physics student who thinks of entering cosmic-ray research will find his appetite whetted, but he will find it rather difficult to extract solid food. The difficulty arises partly from the rather capricious distribution of information among the chapters, and partly from the occasional omission of vital or helpful information. Certain figures, taken from original papers without their context, are unintelligible without prior knowledge; for example, the curves of cosmic-ray intensity at different altitudes and latitudes (p. 93) and the diagram of a complicated counter system (p. 168). The interpretation of several experiments, discussed at length in the book, turns on the way in which the ionization produced by a charged particle depends on its velocity, but this variation is only given in an algebraic form which is not easily apprehended and which is not specially emphasized. It is fair to adduce these points as evidence of hasty planning.

The translation is usually adequate, but it is rather laboured; and in a few places, including the title of Chapter 11, it descends to nonsense.

H. J. J. Braddick

PRESERVATION AND PROCESSING OF FRUIT

Principles of Fruit Preservation

Jam Making, Canning and Drying. By T. N. Morris. (Monographs on Applied Chemistry, Vol. 6.) Third edition, revised. Pp. xiii+206. (London: Chapman and Hall, Ltd., 1951.) 21*s*. net.

THE third edition of this excellent book will be welcomed by those wanting a summary of the current scientific views on fruit preservation. The principles underlying the formation of the pectin gel, the canning of fruit and can corrosion, and dehydration remain the chief subjects considered, while shorter chapters on refrigerating fruits, crystallizing, and fruit syrups and juices are also included. The references at the end of each chapter will be useful to those requiring further information on these subjects.

An introduction on the composition of fruits is very valuable, and the only criticism is that it could with advantage be enlarged to include such things as the proportion of stones present in the stone fruits, as well as more information on the citrus fruits used in making marmalade.

The complex problem of the pectin – sugar – acid gel is very clearly presented, and the text has been considerably revised in the second and third editions to include some of the more recent work on this subject. The chapter on fruit canning not only gives a general outline of the process, but also includes several tables on sugar strengths. The thermal-death-time curves and rates of heat penetration well illustrate the necessity for using different processes for various products.

With so much useful information, it is disappointing to find that the tables for the minimum fruit contents in jams and in cans have not been revised for this edition, and there is no mention of the minimum density of syrup required for fruits canned in Great Britain. The chapters on spoilage and the examination of canned fruits both deal mainly with the problems of can corrosion, and this subject is covered excellently. Bacteriologists would, however, no doubt feel that their side of the examination of cans should be enlarged, especially when examining the less-acid fruits.

The chapters on dehydration are given in considerable detail, while those on cool storage and refrigeration, candied fruits, and fruit syrups and juices are less detailed, but sufficient to outline the main processes. One only wishes the author had included further sections on pickling, sauces and preservation by fermenting fruits. B. A. Crang

ANIMALS IN POSTAGE STAMPS

Zoology in Postage Stamps

By W. Dennis Way and O. D. Standen. Pp. vii+113+33 plates. (London: Harvey and Blythe, Ltd., 1951.) 18*s*. net.

THE collecting of postage stamps by subjects is a hobby now widely practised, and already some dealers issue lists in which collections are arranged thematically. With this trend, it is not surprising to find biological subjects attracting many philatelists. Nor is it only dealers who are attempting to cater for their needs and to win others to their hobby. Museums have realized the value of thematic philately and have built up attractive displays to illustrate a particular subject. In New Zealand, for example, one enterprising museum has recently exhibited a collection of stamps to illustrate the natural history of that country.

Not unexpectedly, this existing and potential interest is now greeted by the appearance of an illustrated book showing the part played by animals in the design of postage stamps. The authors have not been unsuccessful in their endeavour and, besides introducing the philatelist to the animals in his collection, their book may well provide an opportunity for naturalists to gain a new hobby which will enrich and extend their own studies.

Since the purpose of the book is primarily philatelic, the animals, which are nearly all living and include one fossil and no mythological creatures, have been classified in an unusual manner. The more highly organized mammals are treated first; the least highly organized animals of which stamps have been made are described last. Within each group, however, the more primitive types precede the more advanced. Each group thus stands alone and only a general attempt has been made to link one with the

other. The classification of birds has been based on habit rather than anatomy; this need not detract from the zoological value of the book.

The text itself is pithy and relevant, and, besides interesting details about the habits and life-histories of the animals described, introduces items of economics, history, geography and heraldry when these are of current interest.

If this book has a flaw, it is in the way the stamps themselves are displayed. More than 290 stamps are illustrated on a central set of thirty-three plates. These are all in black-and-white and are not always clear. Yet it is the rich colour of the original stamp that one misses—as the attractively coloured dust-cover confirms—and one can only assume that the inclusion of colour plates would have made the price of the book too high. Now that the quality of colour reproduction has reached a high level, however, the authors might have reached a bigger audience if, say, they had confined the animals depicted to the vertebrates and illustrated their stamps in colour. Stamp-saving schoolboys and philatelic adults would have found such a book irresistible. Yet until such a book is produced they will be well content with "Zoology in Postage Stamps", which has grown from the commendable initiative of its authors and publishers.

T. H. HAWKINS

INTRODUCTION TO COLLOID SCIENCE

Colloid Science

By Prof. James W. McBain. Pp. xiv+450. (Boston, Mass.: D. C. Heath and Co.; London: George G. Harrap and Co., Ltd., 1950.) 30*s*. net.

THIS volume by one of the chief workers in the field, with a foreword by Prof. Arthur B. Lamb, is a readable contribution to the ever-growing literature on the subject which is now termed colloid science. It is now generally accepted that the purely descriptive subject of colloids, which was so clearly recognized by Thomas Graham, was put on a much firmer foundation as an exact subject by two important discoveries: the quantitative formulation of the laws of adsorption at an interphase by Willard Gibbs, and the concept of the orientated monolayer as constituting that interphase introduced almost simultaneously but from different points of view by Devaux in France, Sir William Hardy in Britain, and Irving Langmuir in the United States.

Prof. J. W. McBain covers a very wide field in some twenty-seven chapters. The arrangement of the book is admirable. After a brief introduction in which an early chapter is given to the phenomenon of sorption and one to the effective depth of surfaces, the subject is treated in a systematic manner. Exception might be taken to the discussion on emulsions and foams preceding the more general portions of the subject. As might have been anticipated, Chapters 17, 18 and 19, which comprise the subjects to which the author has contributed so much, namely, colloidal electrolytes, protein solutions and non-aqueous colloids, are excellent for their clarity of style.

There must be many who would like to know what colloid science is about, and for such this is an excellent book. For in it one finds a good description of its purpose and of the widespread manifestations of the colloid state. While books of this kind are welcome, they also constitute a danger in that the descriptive parts on colloids and colloid properties still far outrun our exact knowledge and the strictly quantitative aspects of the subject, and it is on these latter that the survival of this, one of the youngest of the scientific family, will ultimately depend.

The volume is well printed, and for a modern book is not unduly expensive.

ERIC K. RIDEAL

PSYCHOANALYSIS AND HAIR

The Unconscious Significance of Hair

By Dr. Charles Berg. Pp. vi+106. (London: George Allen and Unwin, Ltd., 1951.) 15*s*. net.

IN the preface to this interesting monograph, Dr. Charles Berg points out that it is a study which "is really a psychiatric criticism of normality based on a chosen item of typically normal behaviour. . . . Hair activities are chosen merely as a sample of uncritically accepted human behaviour. On examining them in the light of dreams, anthropology, folklore, symptoms and perversions, they are shown to be an expression of instinct-driven tensions and conflicts".

The author discusses normal hair behaviour and suggests its importance by quoting the estimate that there are ten thousand hairdressing establishments in the Metropolitan Police Area of London. Women spend £30,000,000 a year on permanent waving alone. He proceeds to produce clinical evidence from patients' dreams and associations to show that hair is related to sexuality in the unconscious mind, and that cutting it is the unconscious equivalent of castration. He produces also anthropological evidence to support this view, as well as calling on folk-lore and legend. Further evidence suggests pregenital factors are concealed in the emotions concerned with hair, and this is supported by the behaviour in erotic perversions and fetishism. Dr. Berg adheres to the strict psychoanalytical view, and, indeed, his book is a reliable outline of these theories.

There is no doubt that patients do have dreams similar to those described in the book and do produce associations like those which are given. The loss of hair, like the pulling of teeth, is associated with a deprivation which is regarded as a sexual loss. That is, it is unconsciously equated with castration. However, there are other factors concerned in some of the perversions. For example, in exhibitionism there is often a positive seeking of love rather than a denial of castration, and this accords with the exhibitionistic behaviour of the anthropoid when he parades beating his chest before the female. It is a pity that once or twice Dr. Berg quotes an outmoded authority such as Havelock Ellis rather than going to more recent sources. For example, regarding pigmentation and hair on the body signifying hypersexuality, the endocrinologist would point to adrenogenital virilism, and Addison's disease and so on, where it definitely does not do so. However, these are minor matters. The author succeeds in what he attempts to do—that is, give an account of the psychoanalytical theories regarding hair, and the book is well worth reading for those interested in it. The style is clear and erudite. It is well printed on non-shiny paper and well bound in a light-blue colour.

CLIFFORD ALLEN

The Plant Glycosides

By Prof. R. J. McIlroy. Pp. vii+138. (London: Edward Arnold and Co., 1951.) 18*s*. net.

A MODERN monograph on glycosides is long overdue since the subject has not been thoroughly reviewed for twenty years. It is somewhat disappointing, therefore, to find that the present volume only comprises 125 pages of text and that the information in it is incomplete and often inadequate.

After a brief definition of the term glycoside and a short account of the occurrence, extraction and purification of plant glycosides, the nature of their hydrolysis products, the determination of their structures and their functions in the plant metabolism, there follow a number of chapters each devoted to one type of compound, for example, glycosides of alcohols and phenols, thioglycosides and cyanogenetic glycosides. The information about each individual substance varies greatly; in the most complete accounts the melting point, specific rotation (often without temperature, concentration or solvent), plant source (invariably without botanical authority), nature of the sugar portion and of the aglycone and structural formula are given. In many paragraphs the information is extremely meagre, and frequently no physical data are quoted. Some sections, for example, that on the coumarin glycosides, are very incomplete. There are a few tables listing various types of glycosides, and the index of the work is good. There are a short account of analytical methods, and appendixes on the preparation of enzymes and on recent advances.

This work, owing to its incompleteness and general lack of detail, cannot be termed a monograph; but it is a substantial bibliography of the subject containing, as it does, a list of references at the end of each chapter, many of which cite reviews or refer to general aspects of the subject. As such the author earns the gratitude of the chemist.

A. McGookin

Flore du Congo Belge et du Ruanda-Urundi

Préparée par le Comité exécutif de la Flore du Congo Belge et le Jardin Botanique de l'État. Spermatophytes, Vol. 2. Pp. vi+609 (58 plates). (Bruxelles: Institut National pour l'Étude Agronomique du Congo Belge, 1951.) 300 francs.

THE second volume of this fine flora deals with the families from Chenopodiaceæ to Hamamelidaceæ in the sequence of the system of Engler. Among the twenty-six families enumerated the more important are Amaranthaceæ, Caryophyllaceæ, Ranunculaceæ, Menispermaceæ, Anonaceæ, Lauraceæ, Capparidaceæ, Cruciferæ and Crassulaceæ. The descriptions are in French and are precise but adequate. Determination is aided by artificial keys. There are fifty-seven full-page black-and-white line illustrations, nine smaller text-figures, several photographs and two plates in colour. The frontispiece is one of these last and depicts *Sedum churchillianum* Robyns at Boutique, named in 1945 in honour of Mr. Winston Churchill.

The preparation of the work is under the direction of an executive committee, of which Prof. W. Robyns, director of the Jardin Botanique de l'État, is the president. The present volume has a dozen authors who are responsible, entirely or partly, for one or more families, of which the largest is Anonaceæ. In spite of the range of authors, the general treatment is relatively uniform with, however, some variation in the treatment of varieties.

Since the publication of the extensive "Flora of Tropical Africa" (completed except for part of the Gramineæ), the tendency has been to prepare floristic accounts of more restricted areas that nevertheless cover large portions of the continent. When the works now in course of publication or contemplated are fully published, most of Africa within the tropics will be adequately covered by modern floras. Since these are being written in Brussels, Florence, Kew, London and Paris, it is to be hoped that consultations in the recently formed Association pour l'Étude Taxonomique de la Flore d'Afrique Tropicale (A.E.T.F.A.T.) will ensure reasonable uniformity of taxonomic treatment and nomenclature.

W. B. Turrill

Journey through Utopia

By Marie Louise Berneri. Pp. xii+339. (London: Routledge and Kegan Paul, Ltd., 1950.) 16*s*. net.

THE descriptions and critical assessments of the more important utopian writings, from Plato's "Republic" to Aldous Huxley's "Brave New World", which Marie Louise Berneri has compiled is a useful contribution to discussion of the relevance of the development of utopian thought to the history of social conditions and ideas. The book was completed before Aldous Huxley's "Ape and Essence" or George Orwell's "Nineteen Eighty-Four" appeared, and there is no mention of Lord Samuel's "An Unknown Land". Otherwise the book is reasonably complete, and it rescues from oblivion some utopias such as that of Gabriel de Foigny's "A New Discovery of Terra Incognita Australis or the Southern World" of the seventeenth century. There is a good bibliography which includes references to other general studies of the same type which have appeared during the past seventy years. The book is scholarly and a useful reference work as giving a clear warning of some of the dangers which attend the attempt to plan and order society too rigidly, no matter how admirable the ideals on which the plans are based.

Penny Rate

Aspects of British Public Library History, 1850-1950. By W. A. Munford. Pp. ix+150. (London: Library Association, 1951.) 21*s*.; to Members, 16*s*.

NO doubt Mr. W. A. Munford is not to blame for the fact that this remarkably concise history of the 'free' libraries in Great Britain has appeared just a year too late to take full advantage of the public's interest in the treasure-house in its midst that the centenary celebrations in 1950 occasioned. Yet he has an exciting story to tell and one which should be known to a wider public than examination candidates and members of public library committees. A popular version in 1950 might well have helped to confirm the high national regard which the public libraries eminently deserve.

Mr. Munford, whose library very properly shares in the recent rise of Cambridge to city status, is thoroughly at home with the movement of which he writes. His aim is modest and he rightly contents himself with a straightforward historical record of events from Edward Edwards's appearance before the Select Committee in 1849 to the centenary of the Public Libraries Act in 1950. Dates and facts and figures, it is true, abound, but they do nothing to quench their recorder's enthusiasm for his chronicle or to dull his reader's interest in the epic growth of a potent

instrument of self-education. Mr. Munford is at his best when he writes of the administrative problems of staffing, bookstocks, buildings and methods, while throughout he combines the balance of an economist with the ideals of a social reformer. A most interesting appendix on "Mechanics' Institutes and Public Libraries" is contributed by Mrs. Joan Edmundson.

Organic Chemistry

By Dr. P. J. Durrant. Pp. xi+544. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 18*s*.

THE greater part of this book, actually twenty-seven of its thirty chapters, deals with the preparation and properties of organic compounds, interspersed with directions for practical work in a way long made familiar to us by the texts of Perkin and Kipping and of J. B. Cohen. This section is well written, is up to date and covers the ground required for the Advanced and Scholarship Examinations of the General Certificate of Education.

The author has supplemented this conventional treatment by adding some valuable summaries born of his scholarship and experience. Thus, Chapter 1 is a simple but masterly account of the atomic theory and modern views on chemical bonding. It should afford enjoyable and profitable reading for all sorts of chemists. Again, in Chapter 29 the author assembles, discusses and classifies in tabular form the reactions treated in the book. This is a first-rate piece of work and facilitates the study of the various functional groups. Finally, Chapter 30 deals with the production of many compounds on the industrial scale.

At the end of the volume there are thirty pages of questions with answers to the numerical problems. Students should find this book for examination purposes extraordinarily helpful. G. F.

Short-Wave Radio and the Ionosphere

With Special Reference to Everyday Professional and Amateur Problems of Short-Wave Transmission and Reception. By T. W. Bennington. Second edition. Pp. 138. (London: Iliffe and Sons, Ltd., 1950.) 10*s*. 6*d*. net.

MR. BENNINGTON'S little book, "Radio Waves and the Ionosphere", which appeared some eight years ago (see *Nature*, **154**, 413; 1944), aimed at providing a simple, non-mathematical account of the nature of the ionosphere and of the way it influences the propagation of radio waves. The present edition, with an amended title, the scope of which is similar to that of its predecessor on which it is based, has been completely re-written and extended in the light of knowledge acquired in the intervening years.

After an introductory chapter in which the propagation characteristics of radio waves at various frequencies are described, the author proceeds to describe the mode of formation of the various layers of the ionosphere by the sun's radiation, the method of measuring their ionization density and effective height and how these characteristics vary diurnally, seasonally, geographically and with the sunspot cycle. Consideration is then given to the methods by which this information is obtained from soundings made at vertical incidence; and it is applied to waves incident obliquely on the ionosphere. A whole chapter is devoted to the forecasting of the maximum usable frequency for communication between any two points on the earth's surface. This excellent chapter can be recommended to any radio engineer who desires to understand the basic principles and methods of use of forecast charts of the type now published by several national radio research organizations and which are widely used in the planning of radio communications.

The section dealing with amateur transmission will be helpful to the professional as well as the amateur in explaining some of the abnormalities so frequently observed in short-wave radio practice.

The book, which is well produced and illustrated, can be recommended to the radio communication engineer who desires to know more about those regions of the upper atmosphere which enable his signals to travel to the most distant parts of the earth; and also to the amateur, who will find the information provided of great value in helping him to pursue his hobby more usefully.

Statistische Methoden

Für Naturwissenschaftler, Mediziner und Ingenieure. Von Prof. Arthur Linder. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Mathematische Reihe, Band 3.) Zweite, erweiterte Auflage. Pp. 238. (Basel: Verlag Birkhäuser, 1951.) 30 francs.

PROF. A. LINDER has made a valiant attempt to write a universal text-book of statistics covering mathematical foundations and the applications to many diverse sciences—a truly ambitious task. He has made, on the whole, a wise selection of subject-matter, covering measures of location, dispersion and association, the elements of tests of significance (including χ^2-tests), and of analysis of variance; regression, both ordinary- and multiple-, is dealt with rather fully, and the present second edition contains even such advanced topics as discriminant function analysis and the concept of 'generalized distance'.

Following an introduction, in which too much prior knowledge is assumed, there are two large parallel chapters, one on statistical measures, and the other on tests of significance. In the first, the statistics summarized above are developed, described and their computation illustrated by examples, while in Chapter 2 these same statistics are dealt with again from the point of view of their random sampling distributions and of tests of significance associated with them. This necessitates frequent repetitions of formulæ and back- and forward-references. A third chapter deals with the elements of analysis of variance, covering single classification (with equal numbers), double classification (with cell repetition) and three-way classification, which are well described. However, the difficult subject of why and when to use an interaction as 'error' is not adequately discussed. A fourth chapter (intended for the mathematically equipped reader) gives proofs for most of the distribution results used previously. The emphasis is on the geometry of the sample space rather than algebraic derivation.

This book will, no doubt, be of particular value in German-speaking countries. English-speaking readers will be glad to have authentic (and in many cases original) translations into German of well-known Anglo-Saxon statistical concepts, and those who have occasion to communicate about these with German-speaking statisticians will do well to adopt this book as a standard for translation.

THERMONUCLEAR REACTIONS AND ASTROPHYSICS

By H. BONDI
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AND
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NORMAL terrestrial temperature variations do not affect the rate of reaction of the type of nuclear reactions which were discovered first—radioactivity. At present, however, a large number of nuclear reactions are known the rates of reaction of which depend strongly on the relative kinetic energy of two colliding nuclei (because of the effect of the Coulomb repulsion). At sufficiently high temperatures the thermal motion of the (ionized) atoms in a gas can provide this kinetic energy. Some exothermic reactions of this type proceed reasonably rapidly at relatively 'low' temperatures; but the rate of reaction for all such thermonuclear processes is dependent on temperature. Interest in these reactions is not only due to the possibility of artificially inducing such thermonuclear processes, but largely to the astrophysical significance of the phenomena, a significance that is worth discussing in some detail.

We first give a sketch of the development of a star, from the state of a relatively cold and dilute gas cloud to the state of a visible star. If the fate of a gas cloud contracting under its own gravitation is considered, it is readily established that in the first instance the behaviour of the gas is adiabatic. The consequent heating of the central regions, however, gives rise to an inward temperature gradient and hence an outward flow of energy. When the gas has become sufficiently dense to be opaque, the surface radiates this energy into space. The loss of energy leads to further contraction, so that the gain in gravitational energy just balances the loss of radiative energy from the surface, the rate of loss being determined almost entirely by the mass and the opacity of the star. It can easily be shown that the contraction has a time constant of only about one million years.

Since there is strong evidence that the sun and most other stars are much older than one million years, it follows that a source of energy other than gravitation must be responsible for compensating for the radiative loss. Chemical processes can be shown to be wholly insufficient. According to our present state of knowledge, the only sufficient source is nuclear. Since, for a variety of reasons, spontaneous radioactivity is a most unlikely source, the only possibility is nuclear reactions induced in the star as a result of the high temperatures due to the previous gravitational contraction. It is clear that the gravitational contraction will be arrested by that nuclear reaction liberating sufficient energy which occurs first as the temperature of the stellar matter increases. The time-scale of the later developments of the star will then be determined by the rate of exhaustion of the nuclei participating in the reaction. If the nuclear species is common, and the amount of energy liberated of the usual nuclear order of magnitude, the time-scale will exceed the estimated age of the galaxy (some 10^9 years) for all but a few exceptionally bright stars.

The chief astrophysical interest, therefore, is attached to thermonuclear reactions taking place in common type material (that is, astrophysically, hydrogen) at relatively low temperatures. The comparatively small rate of liberation of energy (in the solar case only about 10 ergs per gm. per sec., or less than 1 per cent of the rate of heat generation during animal metabolism, even at the centre) takes place at temperatures of between 10 and 20 million degrees.

Significance of Light Nuclei

As soon as attention is confined to temperatures of this order of magnitude, and consequently to particle energies of a few thousand electron volts, it becomes clear that only very light nuclei can be concerned in the reactions. For heavy nuclei the Coulomb repulsion cannot be overcome sufficiently by particles of these energies for the nuclear forces to become effective. Only a limited number of nuclear species need hence be examined. If a process involving light nuclei is to be exothermic, it must be a building-up process, since the binding energy per nucleon increases with nuclear mass for light elements.

Although temperatures of tens of millions of degrees are quite unobtainable in the laboratory, an experimental study of the processes is not precluded, since non-thermodynamic processes involving streams of particles in accelerators may be used. A serious difficulty in examining the cases of astrophysical interest arises, however, owing to the rarity of the reactions in stars. It may be computed that at the centre of the sun only about one collision in 10^{22} leads to a nuclear reaction. The limitation in the density of the particle streams available for experiments makes reactions of this frequency quite unobservable. If, however, the rate of reaction increases sharply with energy, it may be possible to observe it at higher energies and to extrapolate to the stellar case by means of the formulæ of nuclear physics.

Since the original calculations[1,2] on thermonuclear reactions in stars, great progress has been made in the experimental study[3,4] of the relevant processes. The important nuclear reactions, at least for main-sequence stars, are now fairly well understood[5,6]. The nuclei of lithium, boron and beryllium are used up in times much shorter than the age of the galaxy. For main-sequence stars two reaction chains, the proton–proton chain and the carbon–nitrogen cycle, are of importance. The net effect of each of these chains is the conversion of four atoms of hydrogen-1 into one atom of helium-4 (all ionized), liberating 26 MeV. in the form of thermal energy ($6{\cdot}2 \times 10^{18}$ erg per gm.).

The computed reaction-rates and equilibrium concentrations for these two chains, for conditions roughly similar to those in the centre of the sun, are given in the accompanying table. The rates of generation of energy for the two chains are:

$$\varepsilon_{pp} = (55 \pm 8)\left(\frac{\rho}{100}\right) x_{\mathrm{H}}^{2} \left(\frac{T}{15 \times 10^{6}\,^{\circ}\mathrm{K.}}\right)^{4} \text{erg/gm.sec.;} \quad (1)$$

$$\varepsilon_{CN} = (30 \text{ to } 700)\left(\frac{\rho x_H}{100}\right)\left(\frac{x_{CN}}{0{\cdot}01}\right)\left(\frac{T}{15 \times 10^6\,^\circ \text{K.}}\right)^{18} \text{erg/gm.sec.,} \quad (2)$$

where ρ is the density in gm. per cm.^{3}, x the concentration by mass and T the temperature.

Mean reaction-time t_R and the concentration (by mass) x of the heavier reacting nucleus for a temperature T of $15 \times 10^6\,^\circ$ K., density ρ of 125 gm./cm.$^{-3}$, hydrogen concentration x_H of 0·8 and total concentration x_{CN} of carbon and nitrogen of 0·01

Reaction	t_R	x
$^1H + {}^1H \rightarrow {}^2H + e^+ + \nu$	7×10^9 yr.	0·8
$^2H + {}^1H \rightarrow {}^3He + \gamma$	10 sec.	10^{-16}
$^3He + {}^3He \rightarrow {}^4He + 2\,{}^1H$	3×10^5 yr.	3×10^{-5}
$^{12}C + {}^1H \rightarrow {}^{13}N + \gamma$	10^6 yr.	$x_{C(12)}$
$^{13}N \rightarrow {}^{13}C + e^+ + \nu$	10 min.	$2 \times 10^{-11}\, x_{C(12)}$
$^{13}C + {}^1H \rightarrow {}^{14}N + \gamma$	2×10^5 yr.	$0{\cdot}2\, x_{C(12)}$
$^{14}N + {}^1H \rightarrow {}^{15}O + \gamma$	$<3 \times 10^7$ yr.	$<30\, x_{C(12)}$
$^{15}O \rightarrow {}^{15}N + e^+ + \nu$	2 min.	$4 \times 10^{-12}\, x_{C(12)}$
$^{15}N + {}^1H \rightarrow {}^{12}C + {}^4He$	10^4 yr.	$0{\cdot}01\, x_{C(12)}$

The Carbon–Nitrogen Cycle and the Proton–Proton Chain in Stars

The major contribution to thermonuclear reaction-rates comes from nuclei with relative kinetic energies somewhat larger than the mean thermal energy (5–50 keV.). The rate of reaction of the proton–proton cycle is governed by the first and slowest reaction, which involves a beta-decay. Although this reaction is unobservable in the laboratory, our knowledge of beta-decay theory and two-nucleon wave functions is now sufficiently good to predict the reaction-rate to an accuracy of about 15 per cent. The other reaction-rates for this chain are only estimates, but they are faster than the first one, so that the concentrations of hydrogen-2 and helium-3 are very low.

The carbon–nitrogen cycle consists of four reactions, in each of which a single proton joins the nucleus. The four proton reactions have now been studied experimentally[3,4] for proton energies as low as 100 keV. The computed rates of reaction should be accurate to within a factor of 2 or 3, except for the $^{14}N(p,\gamma)^{15}O$ reaction, where a nuclear resonance in the relevant energy region is suspected (which might decrease the mean life greatly). The mean life of the cycle thus lies between 10^6 years (first reaction) and 3×10^7 years, and the rate of energy production is uncertain by a factor of about 30 (the upper limit for this rate being more probable).

For the sun a central temperature of about $14 \times 10^6\,^\circ$ K. is obtained from the observed mass, radius and luminosity and from equations (1) and (2). The carbon–nitrogen cycle is much more dependent on temperature than the proton–proton chain. Since the temperature decreases outwards from the centre, it follows that the proton–proton chain is active over a much larger volume of the star than the carbon–nitrogen cycle. For the sun, the total energy generations due to the two chains are roughly equal; for much more luminous stars the carbon–nitrogen cycle, and for less luminous stars the proton–proton chain, predominates. This conclusion agrees at least roughly with purely astrophysical data[7] obtained from a study of the Hertzsprung–Russell (luminosity against surface temperature) diagram.

Life-History of Stars

The effect of these stellar reactions is to diminish in the course of time the initially very high abundance of hydrogen. In the case of the sun, all the hydrogen would be used up in some 10^{11} years and generation of energy will then cease. In the most luminous main-sequence stars (more than five times solar mass), however, the stellar hydrogen is used up in a time much smaller than the age of the galaxy. The subsequent development of such a star is therefore of great interest. It can be shown to depend greatly on the rotational velocity, state of mixing, neighbouring matter and other factors. But under the simplest conditions (very little rotation, good mixing, no accretion) the development can be considered in detail[5,8]. When the star consists mainly of helium, production of nuclear energy ceases. Hence the star will contract gravitationally until a temperature of some $10^8\,^\circ$ K. and a density of some 10^4 gm. per cm.^{3} is attained. Under these conditions triple collisions between helium nuclei are sufficiently frequent for the reaction[5]:

$$3\,{}^4He \rightarrow {}^{12}C + 7{\cdot}3 \text{ MeV.} \quad (3)$$

to maintain the radiative energy loss (for some 10^7 years). The rate of generation of energy ε is:

$$\varepsilon \approx 10^3 x_{He}\left(\frac{\rho x_{He}}{2 \times 10^4}\right)^2\left(\frac{T}{2 \times 10^8\,^\circ \text{K.}}\right)^{18} \text{erg/gm.sec.} \quad (4)$$

After all the helium is also used up, the star again contracts gravitationally. The central temperature increases, and heavier and heavier nuclei are built up. When most of the star consists of the most stable elements (iron region), further nuclear reactions can only absorb energy, resulting in still more contraction. If the rate of some of these endothermic reactions increases sufficiently rapidly with density, a sudden collapse of the star may ensue. This may be identified with the observed spectacle of a supernova, and all the heavy elements in the universe may owe their origin to such processes.

If pure deuterium or tritium (hydrogen-3) is available (which is not the case in stars) exothermic thermonuclear reactions can be obtained which are faster than any discussed above. These reactions are:

$$^2H + {}^2H \rightarrow \begin{cases} {}^3He + n + 3{\cdot}3 \text{ MeV.} \\ {}^3H + {}^1H + 4{\cdot}0 \text{ MeV.} \end{cases} \quad (5)$$

$$^3H + {}^3H \rightarrow {}^4He + 2n + 11 \text{ MeV.} \quad (6)$$

At a temperature of $15 \times 10^6\,^\circ$ K. and density of 1 gm. per cm.^{3} the mean life for reaction (5) is about 10^{-3} sec. (it is somewhat longer for reaction (6)) and, under equilibrium conditions, the energy release is about 500 times larger than the initial thermal energy. At $50 \times 10^6\,^\circ$ K. the mean life is about 10^{-5} sec., and the ratio of energy released to thermal (including radiation) energy is about 30. In practice, equilibrium conditions will not apply, and details of the actual arrangements will determine whether the reaction is self-sustaining or not.

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ASPECTS OF THE SILICOSIS PROBLEM*

By Dr. P. F. HOLT
University of Reading

DUST particles which reach the alveoli of the lung become engulfed by phagocytic cells which may carry them to the lymph glands. When silica particles are inhaled, a number of phagocytic silica-laden cells remain in the lung and these tend to clump together, forming patches in which the dust concentration is high. Whether they are in the lung or the lymph glands, the cells are induced to form collagen, with the result that in these patches fibrous tissue replaces areolar tissue. As the condition of the lung advances towards silicosis, the fibrous patches take up a peculiar nodular form. Collagen is a protein which contains a much higher content of hydroxyproline than do other body proteins.

The theory that tissue damage in silicosis is due to the abrasive action of silica dust or to the spiked shape of the particles was challenged by Kettle some twenty years ago. The main evidence against the theory was that silicon carbide dust, which is equally hard, is not injurious, and that when quartz particles are coated with ferric oxide they do not cause on injection the fibrosis which untreated quartz will produce. The alternative theory that quartz slowly dissolves in tissue fluids to produce a toxic silicic acid has found wide acceptance, but the evidence which supports it is still inconclusive. The 'toxicity' of injected silicic acid was demonstrated by Gye and his co-workers[1], who studied tissue changes in the liver, spleen and kidney of mice and rabbits after the injection of silicic acid sols. The 1 per cent sol which Gye used was of a concentration which would gel at *p*H 7 [2] and would be highly polymerized. The conditions of his experiment are not at all similar to those found in the lung, and the possibility of effects such as gel formation cannot be excluded. While King, Stantial and Dolan[3] found that the normal silica content of rabbit urine may be 34 mgm. SiO_2 per 100 ml., representing the daily passage of some 70 mgm. silica through the kidney, Gye and Purdy[4] found damage to the kidney of rabbits when only 0·25 mgm. silica was injected daily. According to Banting[5], sodium silicate or silica gel does not produce fibrosis, yet injected quartz always gives typical fibrotic nodules[6–9].

Other workers have endeavoured to show that minerals which cause silicosis dissolve more readily and give higher concentrations of silicic acid. Because siliceous materials dissolve slowly at room temperatures and the solution in contact with the solid increases in concentration even after several weeks[10], relative solubilities of minerals have been compared by extracting finely powdered material with the solvent and estimating the amount of silica which has passed into solution after a stated time interval. The conditions such as the ratio of mineral mass to solvent mass, range of particle size and temperature have been arbitrarily chosen by every worker, so that figures are seldom strictly comparable. A variety of solvents has been used besides pure water. In an endeavour to simulate physiological conditions, solubilities in plasma, ascitic fluid and isotonic saline have been determined. The values in the following table obtained by King[11] show that there is no sharp differentiation between the solubilities of quartz and sandstone, which are known to cause silicosis, and shale and kaolin, which are probably innocuous.

Solubility of Siliceous Minerals in Ringer Solution

Solute	Solubility (mgm./100 ml.)
Sandstone	1·2
Quartz	6·2
Shale	1·6
Kaolin	0·7

(Extraction time was 48 hr.)

It has been emphasized[12] that a small alteration in the conditions under which a mineral is extracted with a solvent may largely affect the solubility value obtained. Cement provides an obvious example of this. It gives a very low solubility figure if carbon dioxide is completely excluded, but traces of carbon dioxide considerably increase this value. When injected into mice, it dissolves in the tissue fluids and is rapidly excreted in the urine[13]. Inhaled aluminium powder is effective in reducing the amount of fibrosis induced by quartz in the lung, at least in experimental animals[13], and King[14] has emphasized that this discovery was made as a direct result of the observation that aluminium reduces the solubility of siliceous dusts. Consequently, although he recognizes the limitations of the solubility theory, he argues for its retention. Since the large amount of silicic acid which is constantly absorbed into the blood from the normal diet is harmless, he suggests that silicic acid produced from quartz must be in some way different, and he even speaks of "nascent silica". It must be remembered, however, in interpreting evidence for the solubility theory, that solubility is a surface phenomenon and that this property has been largely investigated because it is the one most easily measured. When a mineral is coated with another material, for example, not only the solubility but also all the other surface properties are changed, and any consequent alteration in its power to produce fibrosis is not necessarily directly correlated with its changed solubility.

It has been shown in our laboratory that protein is adsorbed at a quartz surface, and this effect in itself might give wide scope for speculation. Adsorption results in an altered orientation due to the uncoiling of the protein chains, so that the reactivity of certain groups is altered. Adsorption of specific proteins is also a possibility. The adsorption isotherms give no clue as to differences between quartz and kaolin.

Other theories proposed to explain the production of fibrosis by silica were recently reviewed and criticized in *Nature*[15], and need not be considered here. Mention may be made of the observation of Briscoe that, of a number of dusts collected from a variety of industrial atmospheres, all were strongly alkaline. In some cases this alkalinity was due to the hydrolysis at the freshly fractured surfaces of mineral alkali silicates, such as felspar. Since pure quartz can effectively produce silicosis, alkalinity is obviously not the primary cause of fibrosis, but there is some evidence that it may act as a contributory factor. The report of a case in which an abrasive powder, manufactured by grinding together quartz and sodium carbonate[16], proved extraordinarily lethal and produced some of the most rapid cases of silicosis on record lends some support to this view.

Silicon is a normal constituent of animal tissues. Little is known about the nature of compounds in

* Substance of a lecture delivered to the London and South-eastern Counties Section of the Royal Institute of Chemistry on November 3, 1951.

which it occurs; indeed, it is not known whether silicon is, or is not, an essential tissue constituent. The fact that a part of the silicon in dried tissue is soluble in alcohol[17,18] has been taken to indicate that some of the silicon is in organic combination. These experimental findings have been confirmed in our laboratory by using isotopically marked silicon incorporated in silicic acid. There is no evidence, however, that the formation of the alcohol-soluble compounds requires biological activity.

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NOTCHED BAR TESTING OF MILD STEEL

ON December 5, 1951, a symposium on "Notched Bar Testing and its Relation to Welded Construction" was held in the buildings of the Institution of Civil Engineers. It was organized by the Institute of Welding in association with the Joint Committee on Materials and their Testing, and Prof. E. C. Rollason was in the chair. Five papers were presented, and after being introduced by Dr. N. P. Allen, acting as *rapporteur*, were very fully discussed by a gathering of engineers and metallurgists, including many authorities from the Continent of Europe.

Notched bar testing, by which is generally meant the measurement of the energy required to break with a single blow a notched bar of standard form, has been an accepted feature of the testing of heat-treated alloy steels for many years. Its application to ordinary structural mild steel has developed during the past five or ten years, and is a direct consequence of the introduction of welded construction. When riveted construction is used, a few plates or sections of inferior quality may be employed without the whole structure being endangered. A crack developing in a faulty plate will usually spread no farther than the edge of the plate. But when the members are welded together into an effectively continuous and rigid structure, a crack formed at a local fault can spread indefinitely and may bring about the failure of the whole structure. Catastrophic failures have occurred in welded bridges and in welded ships, and have been the cause of much bitter controversy.

Although inquiries into these failures have revealed many defective practices, it has ultimately been recognized that structural mild steel may meet the ordinary specification tests in every particular, and yet lack an ability to offer resistance to the spread of a crack which another mild steel, not noticeably superior in its purity or specified properties, may possess in a marked degree. The inability to resist the spread of a crack is accompanied by an absence of plastic deformation in the neighbourhood of the crack, and is commonly described as susceptibility to 'brittle fracture'. It has been found to be to some extent associated with a low absorption of energy and a crystalline fracture in a notched bar test. Consequently a demand has arisen that mild steels for welding be subjected to some form of notched bar test. It is, however, well known that very strict control over every detail of manufacture is necessary to ensure consistent performance in these tests. Their introduction will restrict the steel-maker's freedom of action and, according to the severity of the test, may increase the cost of the steel and handicap the purchaser in his markets. It is therefore most important that a form of test be adopted which, while providing an adequate degree of security, shall not add unnecessarily to the steel-maker's burdens.

The five papers presented at the symposium comprised two written by steel-makers, and three written by representatives of the user. W. Barr and I. M. Mackenzie considered that the real use of notched bar tests is to guide the steel-makers in the choice of practices for making safe steels. As a result of their systematic use, the steel-maker is already able to supply mild steels in several recognizable grades of resistance to brittle fracture. It remains for the user to decide in the light of experience which grade he requires, and to arrange his testing to ensure that this grade is received. In any notched bar test, a mild steel breaks with a fibrous fracture, characteristic of great resistance to the spread of a crack, if the temperature is high, and with a crystalline fracture characteristic of brittle behaviour if the temperature is low. There is a 'transition temperature', more or less well marked, at which the behaviour of the steel changes, and the quality of the steel in respect of its resistance to brittle fracture is better the lower its transition temperature. If notched bar testing is to be introduced into specifications for mild steel (which, incidentally, these authors did not think necessary) a 10-mm. square bar with an Izod V-notch, as used in current British specifications for alloy steels, is as good a test as any; but the temperature at which the test is performed should be chosen so as to be in the middle of the expected 'transition temperature range' of the steel. A high absorption of energy in breaking the test-piece will then indicate that the transition-temperature range of the sample is on the whole below the test temperature, and a low absorption of energy that it is on the whole above the test temperature.

G. M. Boyd, who presented a review of comparative tests made with different standard types of notched bar, did not entirely agree with this view. He concluded that it is impossible to correlate the results of different kinds of notched bar test in any simple way. The essential reason is that the energy consumed in breaking a notched bar is composed of the energy required to initiate the crack at the root of the notch and that required to propagate the crack through the section, and that these two energies play different parts in every steel and type of test. In his opinion, small notched bars such as the standard Izod test-piece suffer from the disadvantage that the energy required to initiate the crack is too large a proportion of the total energy. In practice, the initial crack is

too often already present, as a result either of defective welding or of accidents in service, and the energy required to extend the crack is the only really important factor. To emphasize its importance, large test-pieces should be employed, and more attention given to the type of fracture—whether accompanied by plastic deformation or not—than to the energy absorbed.

Similar opinions were expressed by Mrs. C. F. Tipper in an account of tests of plates taken from welded ships that had developed cracks in service. In one case, standard Izod impact tests made on small pieces cut from the plate gave the impression that the steel was quite tough at the temperature at which the failure had occurred, whereas tensile tests on considerably larger test-pieces showed clear signs of the onset of brittleness at the same temperature. Mrs. Tipper feared that the use of the existing standard notched bar tests might cause the danger of brittle fractures in ordinary mild steel to be seriously under-estimated and a too optimistic view to be taken of the degree of improvement that is required.

Dr. J. H. van der Veen described an interesting test developed and used by him for testing mild-steel plate at the Royal Netherlands Steel Works. He makes use of a bar, 225 mm. long and 70 mm. wide, and of the full plate thickness, which is slowly bent on edge, as a beam. A small sharp notch, pressed in at the middle of the tension edge, ensures that a crack is formed very early in the test. The mechanical resistance of the beam is measured as the crack spreads through the section, and the nature of the fracture is recorded at the end of the test. If the plate is tough at the temperature of test, the fracture is fibrous throughout, and the resistance of the test-piece rises smoothly to a maximum as the crack lengthens. It then falls gradually to zero. If there is any tendency to brittleness, a point is reached at which the resistance of the test-piece falls suddenly, and the fracture at the same time changes from a fibrous to a crystalline appearance. This change occurs earlier in the test, and the area of the crystalline part of the fracture is greater in plates which are deficient in their ability to resist the spread of a crack; and the test can be used to define a 'transition temperature' below which the toughness of the plate decreases considerably. This type of test has been used before. Dr. van der Veen has worked out its application in detail, and in his hands it has proved to be very discriminating.

Finally, Prof. W. Soete gave an account of an experimental method for measuring the triaxiality ratio of the stress condition produced by a circumferential notch in a tensile test-piece. The brittle behaviour of a notched bar is largely due to the high degree of triaxiality of stress induced by a sharp notch; and Prof. Soete was able to show that in certain steels the triaxiality of stress produced by a given notch is not markedly influenced by the amount of deformation applied to the test-piece, but is highly dependent upon the temperature at which the deformation is applied.

During the discussion of the papers, it became very clear that certain users of welded mild steel intend to insist upon the introduction of some form of notched bar test for mild-steel plate. Not only must the plate be tested, but also the quality of the weld metal with which the plates are joined, and of the adjacent heat-affected zones, must be controlled, for cracks often originate in welds or their heat-affected zones. Although the use of large test-pieces may be desirable from some points of view, too great reliance on large test-pieces is not to be encouraged, for some form of test-piece must be available that can be used for testing small volumes of weld metal and heat-affected material. Several speakers referred to the varying degrees of brittleness exhibited by the weld deposits laid down by electrodes having different types of coating, and it was also pointed out that weld metal is sometimes cold-worked by hammering, and that some weld metals may be seriously embrittled by this operation.

T. S. Robertson stated that the resistance of most steels to the spread of a crack is appreciably lowered by even small amounts of cold work, and that this constitutes an objection to the common forms of notched bar test, in which the steel is inevitably deformed before a crack is produced, and the resistance of the undeformed material to the propagation of a crack is never measured. He described an ingenious experiment in which a strip cut from a plate is cooled at one end to a temperature at which it is quite brittle, and a fine crack produced at the cold end of the strip is forced by the application of stress to spread towards the other end, which is warmed. It is found that in any steel the crack spreads in a brittle manner for a certain distance, until a point is reached at which the temperature is such that the crack will no longer spread unless the steel is plastically deformed. This temperature is characteristic of the steel and is lower in the more crack-resistant steels. The experiment demonstrates the essential property that is required in a steel if it is to resist brittle fracture, but it is too complex to be the basis of a practical test. The value of the simple notched bar test was, however, confirmed by N. G. Leider, who reported that in a Swedish shipyard, where several minor failures of welded structures had occurred, the incidence of failures had been successfully correlated with the results of notched bar tests. Other speakers reported similar experiences.

The principal difference of opinion, however, was concerned with the method of assessing the results of the notched bar test. On one side, it was contended that a structure has failed for all practical purposes if a crack is produced in it, and that the greatest importance should be given to the resistance offered by the material to the initiation of a crack. On the other side, it was asserted that, no matter what precautions are taken, cracks will occur now and then, and that a dangerous structure is one in which the cracks can spread suddenly and catastrophically. From this point of view the initiation of the crack is unimportant, and the energy absorbed in its propagation is paramount. This difference occupied much of the discussion; but it is academic, since in practice the steels that offer a large resistance to the initiation of a crack also offer, as a rule, a large resistance to its propagation. It should not be allowed to obscure the important points upon which all contributors to the discussion appeared to be agreed, and which may be summarized as follows.

(1) There is a need for the production of mild steel for welded structures which is of known and controlled quality in respect of its ability to resist the initiation and spread of a brittle fracture. (2) This quality can be judged by means of suitably applied notched bar tests, and, though different authorities may differ in the procedures they recommend, they will not commonly differ in their assessments of the

relative merits of plates, unless the differences between the plates are small. (3) The present British Standards recommendations for notched bar tests are not suitable for the testing of mild-steel plates, and will require revision if the notched bar testing of mild-steel plates becomes common. In particular, the importance of the temperature of the metal under test is not sufficiently emphasized. (4) There is considerable uncertainty about the standard of quality in respect of resistance to brittle fracture that is required in steel for particular applications. Much study of this subject appears to be needed. (5) The resistance to brittle fracture of weld metal and the heat-affected zones of welds has not yet been sufficiently studied.

N. P. ALLEN

OBITUARIES

Sir Cyril Sankey Fox

THE sudden death of Sir Cyril Fox in Calcutta on December 28, 1951, has come as a shock to all who knew him. Soon after arriving from England he fell ill with pneumonia, and then when apparently well on the way to recovery died suddenly of coronary thrombosis. Science has thus lost a distinguished exponent of engineering geology.

Cyril Sankey Fox was the son of John Henry Neat Fox, and was born in Calcutta on February 24, 1886. He obtained his technical education at the Civil Engineering College, Sibpur, and at the University of Birmingham, where he took the degree of B.Sc. in mining in 1908. He then spent some eighteen months underground at Cannock Chase Colliery, until he was recalled to the University of Birmingham as a lecturer in mining in 1910. (He took the degree of D.Sc. in mining in 1923.)

In 1911 Fox was appointed to the Geological Survey of India as assistant superintendent. He was promoted superintendent in 1930, and succeeded Dr. Heron as director on July 31, 1939. He was knighted in 1943 and retired from the service on January 1, 1944.

Early in the First World War, Fox obtained a commission in the Royal Engineers, and was present at the battle of Loos in 1915 as Brigade Signals Officer, 15th (Scottish) Division. The close explosion of a shell during this action made Fox exceedingly deaf, and he was thereby greatly handicapped for the rest of his life.

In his early years in the Geological Survey of India, Fox was engaged on systematic surveying in the Central Provinces (in the party of the present writer), but after his recall, with other officers, from the war overseas, he was placed in charge of a mica mine at Jorasimar in Bihar. Thereafter his flair for economic and engineering geology was continuously utilized. Besides studying problems in water supply, dam sites and landslips, Fox made in turn surveys of India's bauxite and coal resources. For the latter survey Sir Edwin Pascoe formed a new Coalfields Party and placed Fox in charge. The results of this work spread over some years were presented in a series of memoirs on the geology and coal resources of the coalfields of India, all written by Fox himself (*Mem. Geol. Surv. Ind.*, 57, 58, 59), except for that on the Raniganj Coalfield (61) by Dr. Gee and others. Besides contributing copiously to the departmental publications before he became director, Fox published separate books on bauxite (1927 and 1932), on engineering geology (1935), and, since his retirement, one on the geology of water supply (1949), and another on water that has just appeared post-humously (1952).

Fox received charge of the Geological Survey of India at a very difficult time. With the outbreak of war the staff was promptly concentrated on work of economic importance, and Fox secured the sanction of the Government of India to the formation of a Utilization Branch. He was thus able to employ mining engineers from Burma, rendered available by the Japanese invasion, for prospecting and developing mining propositions such as the lead–zinc deposit of Zawar in Rajputana. The invasion of Burma, and of a part of Assam, with its threat to Calcutta, threw an additional burden on the Geological Survey of India on account of the necessity of packing and removing from Calcutta collections of valuable specimens. In addition, the shortage of paper, and of lead for type, caused by the War, played havoc with the departmental publications, from which they have not yet recovered, in spite of the efforts of Dr. West during his period as director.

After retiring from the Survey, Sir Cyril Fox started a new career as a consulting geologist, and reported between 1944 and 1946 on the mineral resources of several Indian States. These reports, all published by the respective States and on sale, take the form of what the author calls a 'mineral audit' of the possibilities of each State. In 1947 he reported on the geology and mineral resources of the Dhufur Province, Muscat and Oman, in Arabia. At the time of his death, Sir Cyril had extended his operations to Egypt, and had built up a practice in which his services, particularly on problems of engineering geology, were in demand in Arabia, Egypt and India. He had taken a house in Wimbledon, London, from which he conducted his practice.

While in India, Sir Cyril had served as president of the Mining and Geological Institute of India (1936), of the Geological, Mining and Metallurgical Society of India (1943–45), and of the Royal Asiatic Society of Bengal (1942), of which he was made a Fellow in 1939. He was also president of the Geological Section of the Indian Science Congress in 1929. He was a founder member of the National Institute of Sciences of India (1935), a Fellow of the Geological Society of London (1909), and a member of the Institution of Mining Engineers.

Sir Cyril married Mabel Janet Dunn in 1916. Our sympathy must go out to Lady Fox in her unexpected loss.

L. L. FERMOR

WE regret to announce the following deaths:

Dr. W. R. Ivimey Cook, senior lecturer in the Department of Botany, University College of South Wales and Monmouthshire, Cardiff, on February 1, aged fifty.

Dr. W. J. Elford, F.R.S., head of the Division of Physical Chemistry, National Institute for Medical Research, Mill Hill, London, on February 14, aged fifty-two.

Dr. Max Hartmann, of the Pharmaceutical Department of Ciba Laboratories, Basle, where he was concerned in the production of coramine and other medicinal products, on February 2, aged sixty-seven.

Dr. Graham Renshaw, formerly a medical practitioner of Sale, Manchester, and well known as a naturalist, on January 13, aged seventy-nine.

NEWS and VIEWS

Aviation at the Imperial College of Science and Technology : Prof. H. B. Squire

Mr. H. B. Squire has been appointed to the Zaharoff chair of aviation at the Imperial College of Science and Technology, London, in succession to Prof. A. A. Hall, who has recently been appointed director of the Royal Aircraft Establishment, Farnborough (see *Nature*, July 7, 1951, p. 19). Mr. Squire read mathematics at Balliol College, Oxford, where he was an Exhibitioner, and afterwards he carried out research in fluid mechanics for two years under Prof. R. V. Southwell, followed by a year at Göttingen, where he worked under Prof. L. Prandtl on problems of laminar flow stability. In 1934 Mr. Squire joined the staff of the Aerodynamics Department of the Royal Aircraft Establishment, where he remained until 1938, when he was appointed lecturer in the Department of Mathematics, University of Manchester. He returned to the Royal Aircraft Establishment, however, just prior to the outbreak of the War, and remained there until 1949, when as senior principal scientific officer he transferred to the Aerodynamics Division of the National Physical Laboratory. Mr. Squire has made a number of notable contributions to various branches of aerodynamics, and he is an acknowledged authority on fluid dynamics, heat transfer and helicopters. His work has always been informed by an unusually keen physical insight and appreciation of fundamentals. He is perhaps best known for his researches on the stability of fluid flow to three-dimensional disturbances, the profile drag of aerofoils, heat transfer at the surface of a wing, the stability of helicopters, low-drag wings, wings suitable for supersonic flight, and the flow in jets. In addition, he has been responsible for a number of important experimental investigations both in the air and in wind tunnels. His publications include several Reports and Memoranda of the Aeronautical Research Council and the chapters on heat transfer in "Modern Developments in Fluid Dynamics", published under the editorship of Prof. S. Goldstein by the Oxford University Press in 1938.

Institution of Mechanical Engineers : Awards

The Institution of Mechanical Engineers has awarded the James Clayton Prize for 1951 to Dr. H. Roxbee Cox, for his contributions to engineering science and practice, particularly in the fields of aeronautics, power generation and fuel utilization, communicated in part in a Thomas Hawksley Lecture to the Institution in November last ; it amounts to £1,550. Dr. Roxbee Cox, who is a past-president of the Royal Aeronautical Society, was for many years engaged in aeronautical scientific and engineering research and engineering work, and since 1948 he has been chief scientist of the Ministry of Fuel and Power. The first James Clayton Prize was awarded for 1945 to Air Commodore (now Sir Frank) Whittle, for his work in the development of jet propulsion ; Dr. Roxbee Cox worked in association with Sir Frank during the War. The Prize is derived from a fund established by the late Mr. James Clayton, who was a member of the Institution and chief engineer of Courtaulds, Ltd. It is awarded to a member, associate member, graduate or student who, in the opinion of the Council of the Institution, has contributed most in the year to modern mechanical engineering science by way of research, invention, or experimental work, or by a treatise or paper on a modern mechanical engineering subject, or by originality in design, or by service to mechanical engineering.

The Thomas Hawksley Gold Medal of the Institution, accompanied by a premium of £25, has been presented to Mr. J. L. Norton, for his paper on "The Design and Development of the Twin Centaurus Power Plant for the Bristol 'Brabazon' ", this being the best paper read at a general meeting or printed in the *Proceedings* of the Institution during 1951.

Dr. J. C. Davisson : a Tribute by the Bell Telephone Laboratories

The October issue of the *Bell System Technical Journal* (30, No. 4 ; 1951) consists of two parts, the first one of which is a special issue in celebration of Dr. J. C. Davisson's seventieth birthday and contains contributions from his friends and former associates at the Bell Telephone Laboratories. Dr. Davisson, who was born on October 22, 1881, was a research physicist at the Bell Telephone Laboratories from 1917 until his retirement, in 1946, at the age of sixty-five, when he became research professor in the Department of Physics, University of Virginia. Thermionics, electron diffraction and electron optics, and crystal physics have been the main fields of investigation in which Dr. Davisson has made important contributions. He is most widely known for his experiments, together with Dr. L. H. Germer, in 1927, on nickel, in which he demonstrated for the first time the existence of electron waves. Simultaneously, though by a rather different technique, Prof. G. P. (now Sir George) Thomson made the same discovery, and in 1937 Davisson and Thomson shared the Nobel Prize for their important contribution to physics. A portrait, by H. E. Ives, of Dr. Davisson is reproduced as the frontispiece to the special issue, and appreciations of Dr. Davisson as a man and colleague, and of his scientific work, are contributed by Dr. M. J. Kelly, president of the Bell Telephone Laboratories, and by Dr. K. K. Darrow, respectively. The remainder of the issue contains articles describing various experimental and theoretical researches, and these contributions are by members of the staff of the Bell Telephone Laboratories whose work and careers have benefited through close association with Dr. Davisson. A detailed bibliography of Dr. Davisson's published papers concludes the issue.

United Nations Universal Declaration of Human Rights

The influence of the Universal Declaration of Human Rights, during the three years since it was adopted by the General Assembly of the United Nations on December 10, 1948, is appraised in a recent pamphlet entitled "The Impact of the Universal Declaration of Rights", which has been issued by the United Nations Department of Social Affairs (pp. 42 ; London : H.M.S.O., 1951 ; 1*s.* 9*d.*, 25 cents). After setting forth the authority on which the Declaration is based, the pamphlet examines the general reception of the Declaration in the world, both by groups and by individuals, and describes the work of the United Nations Educational, Scientific and Cultural Organization in giving publicity to the Declaration. It then examines the effect of the Declaration in the work of the United Nations and of the Specialized Agencies, as well as its influence on international treaties and agreements and national constitutions and legislation. The Declaration has

already been cited in judicial decisions and opinions of international and national courts, but the pamphlet is to be regarded rather as a praiseworthy piece of publicity for the Declaration than as a serious attempt at an appraisal. Even if the period covered were longer, the limits of the pamphlet preclude any consideration of the deeper considerations which must be taken into account in forming any sound judgment as to the effect of the Declaration on human thought and action.

International Relations Committee of the Textile Institute

To promote the international aspects of its work, the Textile Institute has established an International Relations Committee, with Mr. John Boulton, of Courtaulds, Ltd., Droylsden, Manchester, as chairman. The Institute already has an American Panel, which was established after Mr. Boulton had paid a visit to the United States, and the new Committee is inviting members in India, Australia and South Africa to consider the possibility of forming similar panels there. Contacts are also being established with members in Canada, Switzerland, France, Sweden and Norway. Mainly through its annual conference the Institute already serves as an important link on matters of textile science and technology in many parts of the world, and the new Committee is now taking over responsibility for liaison between the Institute and other textile organizations overseas. The scope of the Institute's outside activities may be gauged from the fact that, of the Institute's 5,600 members, about a thousand reside outside the British Isles, and some 15 per cent of the new members joining the Institute each year are from overseas.

Society for Applied Bacteriology : Winter Meeting

THE winter meeting of the Society for Applied Bacteriology was held on January 9 at the Institute of Structural Engineers, Upper Belgrave Street, London. At the morning session, attended by about eighty members and visitors, original papers were read, and in the afternoon a joint meeting was held with the Microbiology Group of the Society of Chemical Industry (see p. 316). The first papers, presented by T. Richards, Audrey Jones and G. M. el Sadek, were on the detection of lipolytic activities of bacteria using night blue or victoria blue. The organisms are grown on the surface of a nutrient agar (*p*H 7·8) containing a 5 per cent emulsion of the test fat, and the dyes, although temporarily inhibiting bacterial growth at the chosen concentration of 1 in 15,000, indicate lipolytic action by colour changes. In milk, the majority of lipolytic bacteria are of the micrococcus group. Tributyrin is not the best substrate for assessment of lipolytic activity. W. B. Hugo described manometric studies on the effects of phenol, phenoxetol and cetrimide on the respiration of bacterial cells with single substrates, and discussed their possible application to determining bactericidal action. The method appears at present to be unsound, since responses obtained varied according to the substrate used. The action is obviously complex, mannitol and glucose giving rise to an initial stimulation followed by destruction, and succinate and glycerol giving an immediate fall. The growth of moulds on wad materials used in bottle closures was discussed by J. R. Everton and T. E. Bashford. Wood pulp board was less susceptible than bonded cork, and growth was encouraged if there was an air space between the cap and the wad and liner. Mrs. J. M. Barnes compared the efficiencies of cotton-wool swabs against alginate swabs. Since alginate swabs disintegrate completely, it was thought that they may give higher bacterial populations, but experiments with beer glasses, etc., showed no significant difference. D. G. Griffiths and colleagues discussed the relative efficiencies of various methods of sterilization of milk bottles in the dairy, and the methods available for assessing sterility. They suggested that valuable information would be obtained from both plate counts at 30° C. and 37° C. and the 'clot-on-boiling' test.

Abstracting and Indexing of Scientific Literature

THE first report on the activities and the meetings of the Co-ordinating Committee on Abstracting and Indexing in the Medical and Biological Sciences, which has now been issued by the United Nations Educational, Scientific and Cultural Organization (pp. 92. Paris : Unesco ; London : H.M.S.O., 1951 ; 5*s*., 250 francs, or 85 cents), describes the origin of the Committee and its proceedings and decisions to the end of 1949. It includes copies of the resolutions adopted at the preparatory conference during October 3–4, 1947, by the Interim Co-ordinating Committee during April 5–6, 1948, and by the Executive Committee of the latter body during October 15–16, 1948, as well as of the Final Act of the International Conference on Science Abstracting in June 1949. Other papers included are as follows : the report on methods of abstracting considered by the Interim Co-ordinating Committee ; a survey of the work of that Committee, by Dr. Hugh Clegg ; co-ordination of the work of abstracting services, by Prof. M. W. Woerdeman ; the arrangement of bibliographical information in abstracting journals, by Dr. I. Leitch ; abbreviations, contractions and symbols used in the medico-biological sciences, by Mrs. M. Lwoff ; the librarian's preferences regarding abstracting services, by Mrs. E. R. Cunningham ; abstracting services from the user's point of view, by Prof. P. Lépine ; abstracts from the point of view of the abstracting editor, by Dr. G. W. M. Findlay ; and the abstracting organization as an information service, by Dr. C. Wilcocks. All these papers were prepared for the meeting of the Permanent Committee during June 1–4, 1949.

Sinhalite : a New Mineral

IN a paper read at a meeting of the Mineralogical Society on January 24, G. F. Claringbull and M. H. Hey showed that many of the gemstones ranging in colour from pale yellow to dark blackish-brown, and for many years thought to be an iron-rich olivine (peridot), are, in fact, a new mineral having the composition $MgAlBO_4$. It is orthorhombic with unit cell dimensions $a = 4{\cdot}328$, $b = 9{\cdot}878$, $c = 5{\cdot}675$ A. ; space group $Pbmm$, $Pb2_1m$ or $Pbm(2)$. Besides a number of gemstones, one pebble from a gem gravel has been identified. As this and some of the cut stones are known to have come from Ceylon, the name 'sinhalite' is proposed. Sinhalite is much less rare than another new mineral, taaffeite (*Nature*, 167, 438 ; 1951. *Min. Mag.*, 29, 765 ; 1951), of which only two small cut stones are known.

Nuffield Foundation Awards in Dentistry, Biology and the Social Sciences

THE Nuffield Foundation is offering a number of fellowships, scholarships and bursaries in the fields of dentistry, biology and social sciences, as follows.

The fellowships for dentistry are for persons (age 25–35 years) with dental qualifications, to receive additional training in pure and applied science so as to undertake an academic career in dentistry, and also to enable graduates in medicine and science to receive training (not necessarily for a registrable dental qualification) that will fit them for teaching and research in dental health and disease; the fellowships are worth £500–800 a year for one to three years. Dental scholarships, normally for one year only, are available for students at university dental schools in the United Kingdom; they cover tuition fees and a subsistence allowance of not more than £200. The Foundation's scholarships and bursaries in biology and in the social sciences are for graduates of British universities of about 22–35 years of age. The awards in biology are for persons who have graduated in the physical sciences or mathematics, and who wish to pursue such training in biology as will enable them to undertake research and teaching in the United Kingdom in the biological sciences. The scholarships are for those with some previous postgraduate experience and are worth £500–600 (plus fees) a year plus £50 if married and £50 for each of the first two children, together with travelling expenses, etc., where applicable. The bursaries are for those who have recently graduated and are worth £350, with all the allowances already quoted. The awards for the social sciences are the same as those for biology except that the holder may have a degree in any subject other than the social sciences, though one in natural science is preferable; subjects suitable for study are political science, social psychology, anthropology, social statistics and sociology generally, but not economics. Application forms for these various awards must be completed as follows: fellowships in dentistry, by March 1; scholarships in dentistry, by June 30; awards in biology, by April 1; and awards in the social sciences, by May 1. Forms can be obtained from the Secretary of the Nuffield Foundation, 12–13 Mecklenburgh Square, London, W.C.1.

Conference on Human Fatigue

The Ergonomics Research Society is arranging a symposium on "Fatigue", to be held at the College of Aeronautics, Cranfield, Bletchley, Bucks, during March 24–27. The symposium will be opened by Sir Frederic Bartlett, professor of experimental psychology in the University of Cambridge, and by Prof. G. P. Crowden, professor of applied physiology, London School of Hygiene and Tropical Medicine. In addition to a number of lectures and discussions, demonstrations of work study and work measurement will be given in the Department of Aircraft Economics and Production of the College. The symposium is open to non-members of the Society on payment of a fee of 30*s*. Residential accommodation is available in the College. Further details can be obtained from Miss B. G. Murrell, 219 Cromwell Road, London, S.W.5.

Human Relations in Industry

The Ministry of Labour and National Service is organizing a conference on the "Human Relations in Industry", to be held at the Institution of Civil Engineers, Great George Street, London, S.W.1, during March 18–20. The conference will be in the nature of a continuation of the one held in 1948, which became known as the Carlton Hotel Conference and dealt with joint consultation, training and allied subjects. The subjects will cover a wider field than on the previous occasion and will include a discussion of the following factors as they affect man-power and efficiency in Great Britain: employment of those who want to work, including the older worker and the part-time woman worker; helping workers to make the best use of their capacities; physical wastage of man-power; and management–worker co-operation and the will to work. Sir Walter Monckton, Minister of Labour and National Service, will open the conference, and Sir Godfrey Ince, permanent secretary of the Ministry, will be the chairman. Further particulars can be obtained from the Director of Public Relations, Ministry of Labour and National Service, 8 St. James's Square, London, S.W.1.

Announcements

Earl Russell has been elected a member of the Athenæum under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services.

The Council of the Institute of Welding has conferred the Sir William J. Larke Medal, the highest award of the Institute, upon Mr. W. S. Atkins, consulting engineer, for his paper "Continuous Welded Structures—Abbey Works, Port Talbot" (*Trans. Inst. Welding*, April 1951).

Mr. J. C. Eyre, director of agriculture, Northern Rhodesia, has been appointed agricultural adviser to the British Middle East Office by the Foreign Office in succession to Sir Herbert Stewart.

At the general monthly meeting of the Royal Institution held on February 4, Prof. G. I. Finch, professor of applied physical chemistry in the Imperial College of Science and Technology, London, was elected treasurer, to fill the vacancy caused by the resignation of Dr. R. E. Slade.

The Scottish Section of the British Institution of Radio Engineers will hold a conference and exhibition in Glasgow during March 14–15 to mark the opening of the Kirk O'Shotts television transmitter for the Scottish Area. The meeting is open to non-members of the Institution. The registration fee is 7*s*. 6*d*. Further details can be obtained from the local honorary secretary, R. H. Garner, 66 Buchanan Drive, Cambuslang, Lanarkshire.

The Medical Research Council is offering a number of fellowships as follows: Rockefeller travelling fellowships (2,600 dollars a year, or 3,600 dollars for married men) for graduates resident in Great Britain with previous research experience in medicine, to work at a centre in the United States or elsewhere abroad before taking up positions for higher teaching or research in Britain; Eli Lilly travelling fellowships of a similar nature to the Rockefeller awards; and Dorothy Temple Cross research fellowships in tuberculosis (£650 a year, or £900 for married men) for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Britain. All these fellowships carry, in addition, travelling allowance and other allowances. Further particulars and forms of application (to be returned not later than March 15) can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

ENZYMIC REACTION BETWEEN ARGININE AND FUMARATE IN PLANT AND ANIMAL TISSUES

By Dr. DAPHNE C. DAVISON and Dr. W. H. ELLIOTT
Biochemical Laboratory, University of Cambridge

DURING the course of investigations into the mechanism of asparagine synthesis in plants, the enzymic formation from arginine and fumarate of a hitherto unknown ninhydrin-reacting amino-compound has been observed. The enzyme system appears to be very active and has been found in a wide variety of cells.

Throughout this work chromatograms were set up as follows. Each solution was deproteinized by the addition of an equal volume of ethanol, and the supernatant, after centrifuging, evaporated under reduced pressure at temperatures below 40°. The residue was then dissolved in 1 ml. of 20 per cent ethanol and a small sample transferred to Whatman No. 3 filter paper using a micro-pipette. Chromatograms were run using phenol/water solvent in an atmosphere of 0·3 per cent ammonia and coal gas. After drying, the papers were sprayed with ninhydrin in the usual way. Under these conditions, the new compound had an R_F value of *c.* 0·2, which lies between the R_F values of glutamic acid and serine. This did not correspond with any of the simple amino-acids.

The compound was observed to be present initially in aqueous extracts of dry pea meal. After incubation of an extract of dry pea meal alone for 6 hr. at 37° in the presence of 0·02*M* phosphate buffer, *p*H 7·3, a marked increase in the intensity of the new spot was observed on the chromatogram. This was further enhanced (in the case of the crude extract) by the addition of 0·02*M* L-aspartate, L-malate, fumarate or oxaloacetate. Toluene was added to prevent bacterial growth. The same results were obtained using the supernatant from high-speed centrifugation of the crude extract. No formation of the compound occurred if the extract had been previously boiled; complete loss of activity also occurred on dialysis of the extract, but this could be restored by the addition of arginine together with malate or fumarate. Aspartate was no longer active unless boiled extract was also added. Arginine could not be replaced by any other L-amino acid tested (serine, glycine, alanine, β-alanine, leucine, ornithine). Crude extracts of ground *Lupinus angustifolius* seeds were not active unless arginine as well as fumarate or malate was added. This can be correlated with the observation that this extract, unlike that from peas, showed no arginine spot on chromatographic analysis.

After fractionation of the crude pea extract by isoelectric precipitation, very little formation of the new compound was observed in any of the fractions when incubated with malate + arginine. When malate was replaced by fumarate, however, most of the original activity was recovered. The enzyme preparation was prepared as follows. Finely ground pea meal was extracted by stirring with 3 vol. of water for 20 min. The suspension was centrifuged, the cloudy supernatant cooled to 0° and adjusted to *p*H 5·1 with *M* acetic acid. The precipitate was centrifuged off at 0° and the supernatant brought to *p*H 4·2 with more acid. The precipitate was washed with cold 0·01*M* acetate buffer, *p*H 4·3, and dissolved in dilute buffer (about a sixth of the original volume of extract) by adding alkali to *p*H 7·3.

Fig. 1 shows that in the presence of fumarate and enzyme the arginine almost completely disappears (Exp. 1). A trace of arginine, too weak to show on the photograph, was visible on the original chromatogram. This disappearance was accompanied by the formation of the new spot between glutamic acid and serine. No reaction occurred with boiled enzyme (Exp. 3), nor did the compound appear when the enzyme was incubated with fumarate alone (Exp. 2) or arginine alone (Exp. 4). Exp. 5–7 show that fumarate cannot be replaced by oxaloacetate, maleate or aspartate. In Exp. 8 a small amount of the new spot was formed from malate + arginine, but since this was only a small fraction of the amount in Exp. 1, this activity may be due to the formation of fumarate by traces of fumarase in the enzyme preparation. The activity of crude extract with aspartate and oxaloacetate is also presumably due to the enzymic formation of fumarate from these substrates.

The compound can be synthesized on a large scale. Fig. 2 shows the progress of an incubation using 4 gm. L-arginine hydrochloride and 2·18 gm. fumarate at *p*H 7·3. It can be seen that after 40 hr. at room temperature most of the arginine had disappeared; there was a parallel increase in the intensity of the new spot. No reaction occurred in a small sample of the incubation mixture which was first heated to 85° and then left for 40 hr. at room temperature.

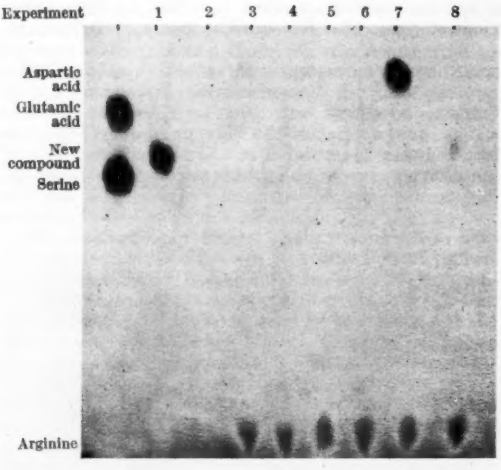

Fig. 1. Incubations were carried out at 37° for 2 hr. in tubes containing the following mixture as the complete system: 0·02*M* phosphate buffer, *p*H 7·3; 0·03*M* L-arginine hydrochloride; 0·05*M* sodium fumarate; 1·5 ml. enzyme preparation; final vol. 4·2 ml. All solutions were brought to *p*H 7·3 before addition. 1, complete system; 2, no arginine; 3, enzyme boiled; 4, no fumarate; 5–8, fumarate replaced by 0·05*M* oxaloacetate, maleate, L-aspartate and L-malate respectively

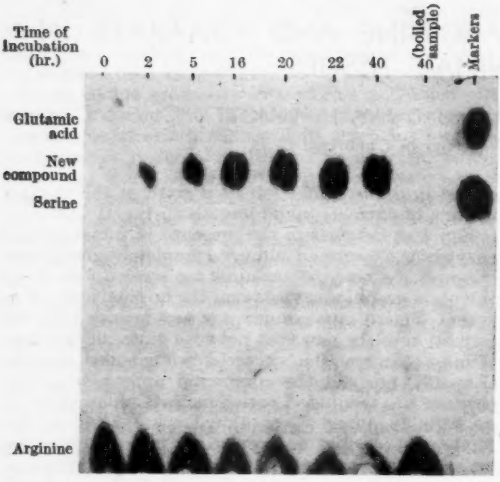

Fig. 2. Incubation at room temperature in the presence of toluene. The reaction mixture contained, in 0·01*M* ammonium acetate buffer, *p*H 7·3; 4·0 gm. L-arginine hydrochloride; 2·18 gm. fumaric acid (both substrates at *p*H 7·3) and 50 ml. purified enzyme solution; total vol. 250 ml. 0·05-ml. samples were transferred directly from the digest to the paper

Samples of the reaction mixture after incubation were run as continuous bands across washed Whatman No. 3 papers, and a solution of the new compound obtained by elution of the strips cut from the paper. Preliminary chemical studies show that the compound is completely destroyed by heating the solution at 110° for 16 hr. Altogether four major breakdown products have been detected, the products formed varying with the *p*H of hydrolysis. With 6*N* hydrochloric acid spots corresponding in position with arginine and ornithine, together with another strong slower-running component, appear on chromatograms run in phenol/water/ammonia. Assuming that the spot in the ornithine position is, in fact, ornithine, the result suggests that the amidine group of arginine is involved in the reaction with fumarate, since arginine itself does not break down in acid. There is insufficient evidence at present to interpret the results of hydrolyses in terms of chemical structure, though they suggest that the compound is rather labile and capable of breaking down in a variety of ways. Large-scale isolation of the compound using further purified enzyme preparations is in progress.

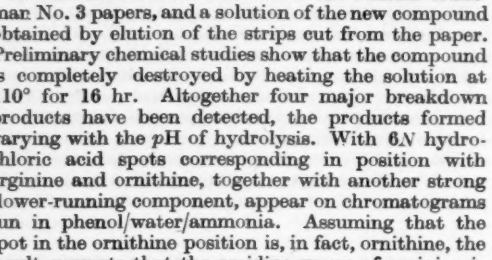

Fig. 3. Incubations carried out at 37°. The complete system contained 0·02*M* phosphate buffer, *p*H 7·3; 0·02*M* L-arginine hydrochloride; 0·03*M* sodium fumarate and 2·0 ml. rat kidney homogenate. Final vol. 4·0 ml.

Dialysed extracts of a variety of animal tissues have been found to be very active in catalysing the formation from arginine and fumarate of a compound which appears in the same position on chromatograms as that produced by the plant enzyme. Fig. 3 shows the results of experiments with rat kidney. The tissue was ground with 4 vol. of water in a glass homogenizer of the Potter and Elvehjem type and the homogenate dialysed with stirring against ice-cold phosphate buffer for 3 hr. A compound which gave an intense spot on the chromatogram, running between glutamic acid and serine, was formed in the presence of arginine and fumarate (Exp. 3), while a control sample to which ethanol was added initially contained none (Exp. 1). Similarly, none was formed in the presence of arginine alone (Exp. 2). Results of this type have also been obtained with dialysed extracts of sheep heart, sheep pancreas and with cell-free extracts of yeast and *Proteus vulgaris*.

The purification of the enzyme is being continued. Work on the chemical structure and further metabolism of the new compound will be reported elsewhere. One interesting possibility is that a reaction between the amidine group of arginine and fumaric acid could conceivably produce a structure related to orotic acid or other pyrimidine precursor.

We are grateful to Dr. F. Sanger and Mr. E. Thompson for assistance and advice. Our thanks are also due to Dr. C. S. Hanes for advice and for gifts of washed chromatographic papers. [Aug. 17.

CLASSIFICATION OF PROTEOLYTIC ENZYMES BY MEANS OF THEIR INHIBITORS

By Dr. TAGE ASTRUP and NORMA ALKJAERSIG
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A PROTEOLYTIC enzyme is commonly classified as being (1) pepsin-like, (2) trypsin-like or (3) cathepsin-like. This classification is mainly based on the region of *p*H in which the optimal enzymatic activity is obtained. It was a great step forward when Bergmann[1] proposed to group the proteases according to their action on some simple synthetic peptides. By means of such substrates it was possible to characterize an enzyme according to the chemical configuration of the specific groupings on which it was able to act. The knowledge gained in this way is essential to the understanding of the mode of action of the enzymes in question.

In a comparative investigation of proteolytic enzymes, the classification according to the mode of action on such simple substrates as di- and tripeptides is not complete, because all the properties of an enzyme as a protein are not expressed towards such simple chemical substances. Enzymes of different origins may produce the same action but may be essentially different in nature.

ACTION OF PROTEOLYTIC INHIBITORS ON FIBRINOLYTIC ENZYMES (at pH 6·4)
÷ denotes inhibition, O means no effect, and + represents an increase in activity. Effects marked — have not been investigated

	Cellulose-trisulphuric acid	Heparin	Soybean trypsin inhibitor	Serum	Lauryl-sulphonate	Cetyl-pyridinium-chloride	Laurylamine
Trypsin	÷	(÷)	÷	÷	÷	+	(+)
Chymotrypsin	÷	O	÷	÷	÷	÷	÷
Plasmin	÷	÷	÷	÷	+	÷	÷
Aspergillus protease	O	O	O	÷	+	+	÷
B. subtilis enzyme	O	O	O	÷	—	—	—
Ficin	O	O	O	÷	—	—	—
Papain	÷	÷	O	÷	—	—	—

It was thought that proteolytic enzymes might be classified by studying their behaviour towards a number of proteolytic inhibitors. The action of the enzyme on its substrate is used in this procedure, not as a means of characterizing the enzyme, but only for estimating the degree of influence of certain agents on the enzymic activity. This gives a much wider variability of the reactions involved. In this manner it was thought it might be possible to differentiate between proteolytic enzymes the action of which on simple substrates is identical.

Proteolytic enzymes may be inactivated by a number of unspecific chemical or physical procedures which influence the protein molecule[2–4]. Such reactions are of little use in the identification of the individual enzymes. This applies also to the inactivation of enzymes containing thiol groups by means of oxidative agents.

The reactions useful in the classification of proteolytic enzymes are those which show an inhibition of proteolytic activity by compounds which do not interfere markedly with other enzymes and proteins. Such compounds have been found in increasing numbers during the past few years (for references see footnote 5).

The proteinases which we have been studying are those which produce fibrinolysis at about neutral reaction. The activity was estimated by the fibrin plate method[6]. This method uses a fibrin film formed in a Petri dish. The activity is expressed as the product of two diameters of the lysed circular zones. The method is very sensitive and simple, and can be used for the estimation of a number of proteolytic enzymes, though the relation between enzyme concentration and lysed area is not linear[7]. Pepsin produces no lysis in this method. The enzymes investigated include: crystalline trypsin, crystalline chymotrypsin, plasmin (human, streptokinase-activated), an *Aspergillus* protease (obtained from Dr. W. G. Crewther[8]), a proteinase from *B. subtilis* (obtained from Prof. K. Linderstrøm-Lang, Carlsberg Laboratory, Copenhagen), and commercial samples of ficin and papain. Some of the results obtained are collected in the accompanying table.

The inhibitors investigated belong to different types. It is well known that blood serum (ox) contains inhibitors of proteolytic enzymes, and, as is seen from the table, serum is the only agent which inhibits all the enzymes studied. The soybean inhibitor acts on fibrinolytic enzymes of mammalian origin, but it is without effect on the microbial and plant proteinases.

The anticoagulant and antifibrinolytic properties of heparin are well known. We found a slightly inhibitory effect on trypsin, no effect on chymotrypsin, and a considerable effect on plasmin. It has no effect on the microbial proteinases and ficin, though papain behaves differently and is inhibited. Cellulose-trisulphuric acid (and chitindisulphuric acid) act in much the same manner, though trypsin and chymotrypsin are both inhibited. The difference in the action of heparin on trypsin and on chymotrypsin was observed by Horwitt[9].

It was recently found that quaternary detergents (cetylpyridinium chloride and lauryl-benzyldimethylammonium chloride) showed a very peculiar behaviour towards plasmin and trypsin[10]. They increased the fibrinolytic activity of trypsin considerably at all concentrations. Small concentrations increased the activity also of plasmin, whereas larger concentrations showed a strong inhibitory effect. Both decreased the activity of chymotrypsin and increased the activity of the *Aspergillus* enzyme. A number of non-detergent amines (including quaternary bases) were tried without any effect; but laurylamine produced a slight activation of trypsin and decreased the activity of chymotrypsin and plasmin, as well as that of the *Aspergillus* enzyme. An organic dye (Janus green) did, however, decrease the activity of all the enzymes, excepting trypsin, where no effect was observed.

Turning now from the cationic to the anionic detergents, it was found that laurylsulphonate inhibited trypsin, chymotrypsin and plasmin but increased the activity of the *Aspergillus* protease. This is very remarkable because the *Aspergillus* protease is activated also by the quaternary detergents. Similar results were found with 'Tergitol 7' (a secondary alkyl sulphate) and with tocopheryl-phosphate, which is known to be antiproteolytic[11].

The inhibition of the proteinases was found in a number of cases to be reversible. Thus an inactive mixture of trypsin and 'Tergitol' was reactivated by addition of lauryl-benzyldimethylammonium-chloride in increasing concentrations, and the final activity was almost identical with the increased activity obtained by adding this cationic detergent to the trypsin solution alone. A mixture of plasmin and 'Tergitol' was reactivated by adding cetylpyridinium chloride in a certain concentration; an excess produced a decrease in this activity.

The interactions described here are useful in that they present a more detailed classification of proteolytic enzymes than has hitherto been used. Information may also be obtained which promotes a better understanding of the differences in the actions of the various proteases, though the relationships are not so simple as those presented by Bergmann and his collaborators. It would be tempting to suggest a relationship between the increase of activity of the fibrinolytic property of trypsin and the structural specificity needed for its action, namely, the availability of lysine and arginine residues, as indicating an increased access to these groupings after acidic groups in the neighbourhood have been blocked by the cationic detergents. The dual activation of the *Aspergillus* enzyme by cationic as well as of anionic detergents, however, makes such a simple explanation

unlikely. The reaction might also be compared with the effect of higher organic anions on proteins studied by Steinhardt[12], where an increased proteolysis was produced.

The experimental details of these investigations are being prepared for publication elsewhere.

[Sept. 11.

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DISINFECTANTS

A SYMPOSIUM on "Disinfectants" took place at a joint meeting of the Society for Applied Bacteriology and the Microbiology Group of the Society of Chemical Industry held at the Institute of Structural Engineers, Upper Belgrave Street, London, on the afternoon of January 9. Papers were contributed by Prof. H. Berry (School of Pharmacy, University of London), Dr. P. Maurice (Imperial College of Science and Technology, London), Dr. L. A. Allen (Water Pollution Research Laboratory, Watford) and Mr. J. C. L. Resuggan (British Hydrological Corporation, London). Dr. S. E. Jacobs (Imperial College of Science and Technology, London) was unable to present his paper owing to illness.

Prof. Berry, discussing the bactericidal action of phenols in aqueous solutions of soaps, said that phenolic bodies, sparingly soluble in water, can be readily solubilized in soap solutions, quoting as an example benzylchlorophenol in potassium laurate solution. This increased solubility is due to micelle formation, since it has been shown that practically none of the phenol is in the free aqueous phase. Solubility increases with soap concentration until a maximum is reached, representing a maximal size of complete micelle formation. Beyond this point, the micelles are apparently unable to solubilize any more of the phenol. Bactericidal action is postulated as the result of adsorption of the micelle on the cell walls. Bactericidal efficiency is found to be at a maximum at the 'critical concentration' of the soap, that is, when the completely formed micelles are saturated with the phenol. It is dependent on the proportions of soap and phenol present, but independent of concentration of the mixture, since dilution may give rise to increased rates of kill. Prof. Berry directed attention to errors which may be inherent in the usual methods of determining bactericidal efficiencies, due to bacterial clumping by the surface-active agents, and described a technique which was designed to overcome this.

Dr. Maurice described the results of studies on the action of antibacterial substances on the permeabilities of bacterial cells, and suggested a method based on these findings for determining bactericidal activity. When a basic dye, such as basic fuchsin or safranin, is added to a bacterial suspension there is a progressive increase in turbidity, due to absorption of the dye into the cell cytoplasm. Addition of bactericides, such as phenol or cetrimide, results in a rapid rise in the rate of increase of turbidity. Turbidities are measured on a Spekker absorptiometer, and the graph of the logarithm of drum reading against time yields a straight line. Selection of a dilution of the test substance which gives the same response as a standard phenol solution affords a means of calculating a 'phenol equivalent activity'. The advantage claimed for the method is that a more precise physical measurement is made in place of the usual biological end-point determination.

The presence of certain cations influences considerably the response. Calcium ions at concentrations as low as $M/10{,}000$ inhibit to some extent the dye absorption, and trivalent ions are even more inhibitive; monovalent ions and all cations examined were apparently without effect.

In his paper on the bactericidal action of chlorine, Dr. Allen dealt with some of the factors affecting its efficiency. Bactericidal action is related to the degree of ionization of the hypochlorous acid formed when chlorine is dissolved in water. The *p*H value is highly important, greatest activities being found in acid media. This observation is important in dealing with sewage effluents, which often have *p*H values of about 9, and with waters of about *p*H 8, when longer contact times are necessary to achieve disinfection. Efficiency is not unduly affected by the concentration of chlorine, but is increased considerably with temperature, this being more marked with the chloramines than with chlorine solutions.

The presence of organic matter is generally considered to reduce the bactericidal activity of chlorine; but a review of the information available shows that comparatively few organic compounds react under conditions naturally encountered. Moreover, reactive compounds do not all have the same adverse effect. For example, peptone and sewage of the same chlorine demand behave differently; the former brings about complete loss of the bactericidal action of the chlorine, but the latter produces at first only a slight effect. This is attributed to the ammonium ions present in sewage, which combine to give chloramine.

Chloramine is highly active as a bactericide, but not as rapid in its action, or reactive with other compounds, as chlorine. Solutions of chlorine and ammonia give a typical 'break-point' in the dose-response curve, and thus with the same level of residual chlorine it is possible to obtain three different bactericidal effects.

Mr. Resuggan, describing some of the anti-bacterial properties of the quaternary ammonium compounds, first considered their general configuration and their physico-chemical properties. An outstanding characteristic is their high surface activity, and this parallels to some extent their high anti-bacterial activity, although at the same time it is responsible for difficulties in determining such activity. Quaternary ammonium compounds are used extensively in the hygiene of the various branches of the food industry; but, owing to their sensitiveness to organic matter, should be used only for disinfecting relatively clean surfaces. Mr. Resuggan claimed that their toxicities, chronic or acute, are far above the levels which would be encountered normally, and thus their continued use would not prove harmful in practice.

The excessively high bactericidal values at first claimed for these compounds have now been disproved, having been shown to be due to micelle formation, clumping and residual bacteriostatic effects. These arise from their high surface activity and consequent intense adsorption to bacterial cells and other surfaces, an effect not easily removed by simple washing or dilution. Only by the use of suitable quenching agents, usually anionic compounds, can the effect be eliminated. The compounds generally are more active against Gram-positive than Gram-negative organisms. Suggested explanations of the mode of action of the quaternary ammonium compounds include the preferential destruction of the bacterial enzyme proteins, cytolysis of the cell with escape of intracellular substances, and final lysis resulting from surface action.

GASEOUS ELECTRONICS

CONFERENCE AT SCHENECTADY

THE fourth Conference on Gaseous Electronics, sponsored by the Division of Electron Physics of the American Physical Society, was held during October 4–6 in the new Research Laboratory at Schenectady of the General Electric Co. In the field of fundamental processes three main problems were discussed, namely, the role of rare-gas molecular ions, the formation of negative ions and photo-ionization in gases.

Using a new mass-spectrometer in which the kinetic energy of the ions is measured by applying retarding potentials after deflexion, H. D. Hagstrum (Bell Laboratories) reported that he has studied the critical energies necessary for electrons to produce various reactions by colliding with diatomic molecules, namely, carbon monoxide, nitrogen, oxygen and nitric oxide, and the nature of the ions formed. From the results, dissociation and electron attachment energies were derived. When a Townsend discharge, for example, in argon, is initiated by a light pulse of duration 10^{-7} sec. striking the cathode, it is found that the current as a function of the time decays in several steps. J. A. Hornbeck (Bell Laboratories) has shown that this phenomenon is associated with the neutralization of molecular and atomic ions at the cathode. From the measurements follows the ratio of the number of excitations to ionizations in various noble gases, as well as the product of the life of certain atomic states and the cross-section for excitation by electrons in a given field E/p. In the presence of molecular ions, similarity relations like Paschen's law fail.

M. A. Biondi (Westinghouse) has observed by microwave measurements the decrease with time of the concentration of negative ions in a decaying gas-discharge and derived from it the cross-section for thermal electrons of 0·04 eV. to become attached to oxygen molecules. In the pressure range 10–30 mm. of mercury, the cross-section seems to be independent of the pressure, and its value ($\sim 10^{-22}$ cm.^{2}) agrees with the theoretical one for radiative capture. A similar problem has been attacked by M. Harrison and R. Geballe (Washington University), who measured ionization currents in uniform fields between $E/p = 30$ and 80. The sharp apparent decrease of the ionization coefficient α/p with falling E/p at low fields is ascribed to the attachment of electrons to oxygen molecules which dissociate into O and O^-. This seems to be the case even in strong fields. T. Holstein (Westinghouse) said that he has treated theoretically the dissociative attachment by applying the Franck–Condon rule. For example, $O_2 + e \rightarrow O + O^-$ is such a process. It occurs in two stages: an electron is captured and the molecular ion dissociates. However, when dissociation occurs, the electron can become detached. The cross-section for the process has been calculated and agrees in order with the one computed for light atoms; it contains the probability of auto-detachment which as yet is not known.

In order to determine photo-ionization cross-sections of molecular gases, G. L. Weissler and N. Wainfan (University of Southern California) use a spark source in helium at low pressure, producing lines of constant intensity in a vacuum spectrograph, and irradiate nitrogen and oxygen at low pressure. The ionization in the gas as a function of the wave-length is measured with an ionization chamber, and the energy of the radiation with a thermocouple. Preliminary results show that ionization in nitrogen occurs only below 800 A., corresponding to the ionization potential of the nitrogen molecule. A. O. McCoubrey (Westinghouse) reported on the band fluorescence of mercury vapour. Irradiation at 2537 A. produces atoms in the resonance state which collide with unexcited atoms and form metastable ones. These, too, collide with normal atoms, as a result of which metastable molecules are produced in a state that decays either by spontaneous or by collision-induced radiation. The former process is slow and gives rise to the ultra-violet band; the latter produces the visible band. The ratio of the band intensities has been found to be proportional to the square of the vapour density, confirming the above processes.

C. F. Hendee (North Western University) has investigated the decay of the positive bands of nitrogen. A condenser charged to 10 kV. was discharged through a tube with external electrodes producing light-flashes. The emission of the first positive band is preceded by a transition from a metastable (singlet) into a normal (triplet) state. The decay involves collisions and thus takes ten times as long as the decay of the second positive band, which involves a normal singlet–triplet transition.

An account was given by A. V. Phelps (Massachusetts Institute of Technology) of his investigation of the ambipolar diffusion in a helium discharge by determining the electron density from the change of the resonant frequency of a cavity and the type of ions by means of a mass spectrometer. Below a pressure of 1 mm. of mercury, He^+ ions are formed which diffuse to the wall, and above 5 mm. of mercury, He_2^+ ions are formed. The large electron recombination coefficient is due to the molecular ions.

J. Slepian and L. S. Frost (Westinghouse) reported that they have found that measurements on the ambipolar diffusion in a decaying plasma can give results which do not agree with Schottky's theory. This is the case if the decay-rate is counteracted by ionization in the gas, or if the probe emits electrons, or if the charge density is not large enough to produce ambipolar flow, or if the pressure is so low that the mean free ionic path becomes comparable with the tube radius.

A series of papers dealt with questions concerning the discharge plasma. D. Gabor (Imperial College of Science and Technology, London) discussed the

scattering of an electron beam which passes through a highly ionized and excited gas. He reported on the experiments by A. E. Ash, who measured the diffusion of a weak beam which passes along the axis of a cylindrical hot cathode coated inside with barium and strontium oxides. This layer emits positive ions which neutralize the electron space-charge. The evaluation of the experiments shows that the short relaxation distances cannot be explained by energy and momentum exchange between electrons colliding with ions and electrons. It is suggested that plasma oscillations are the cause of the strong interaction between beam and plasma.

I. B. Bernstein and T. Holstein (Westinghouse) gave an account of their theoretical investigation of the electron energy distribution in a constant (in time) space-charge field, the collisions and the superimposed A.C. field being treated as perturbations. The Boltzmann equation now contains the sum of electrostatic and kinetic electron energy which is constant, since the energy change per oscillation is assumed to be small. The resulting difference-differential equation has been solved. It was concluded that the space-charge field does not change materially the distribution or the rate of ionization for conventional values of the field (E/p), compared with results obtained for zero space-charge.

R. G. Fowler and D. Compton (University of Oklahoma) discussed their research on the properties of those luminous fronts—preceded by a shock wave—which are produced by low-pressure sparks with high peak currents. It is found that the speed of propagation is that of sound. The spectrum is not an afterglow. The gas has a high ion concentration as derived from Stark broadening. The spectral intensity is proportional to the square of the ion concentration, pointing towards radiative recombination.

A paper by J. Backus and N. E. Houston (University of Southern California) outlined their study of the energy distribution of positive ions produced by a pulsed glow discharge of duration 50 μsec. between copper electrodes in argon at about 1 micron pressure at 0·3 amp. in a magnetic field of 2,000 oersteds (Philips gauge). After the discharge was switched off, the ion current behind the cathodes was measured oscillographically, and from it the distribution was found to be nearly Maxwellian, the mean energy corresponding to about 1 eV. Another paper, by C. G. Smith (Raytheon), was on his continued studies on the retrograde motion of the cathode spot of an arc which is anchored to a 'Carboloy' cylinder projecting a few mm. above the surface of a mercury pool. The speed of the spot rises with the field, being considerably faster than sound in mercury vapour at 16,000 oersteds. However, the cause of the motion in the 'wrong' direction is still unknown.

G. Medicus and G. Wehner (WCESD, Wright Field) said that, by using an anode with a low work function (barium layer) and a hot cathode with a high one (tantalum) in xenon at a pressure of 0·2 mm. of mercury, they have observed a negative voltage drop develop across the discharge (0·8 V. at 0·5 amp.). The discharge is a low-voltage arc with a potential maximum between the electrodes; the negative p.d. is due to the contact potentials of the electrodes with respect to the gas. They gave a report on the errors in the evaluation of probe measurements which are due to changes in the work function of the probe. For example, when the tungsten probe is near a coated cathode, these changes occur so fast that it is necessary to make measurements with a probe a few seconds after it has been cleaned. However, by applying this technique, Maxwellian distributions of electron energies have been found to exist over a range of probe currents of $1 : 10^4$ when the probe is 1 cm. from the cathode.

W. M. Webster (R.C.A.) found that at pressures greater than 1 mm. of mercury recombination at the surface of a probe becomes so appreciable that the concentration of charge as measured by the probe can be ten times smaller than in the undisturbed plasma. This can be demonstrated optically, or by using an electrolytic tank or by measurements at the wall of the discharge vessel. The electron temperature is found to be little affected. S. Schneider (Signal Corps, Ft. Monmouth) described how he has studied the clean-up in various parts of thyratrons filled with 99 per cent hydrogen and 1 per cent tritium at a pressure of 0·6 mm. of mercury; he uses β-ray counters and auto-radiographs. Preliminary results show that those parts of the surface which are covered with evaporated substances or are under strain bind tritium readily. M. J. Reddan and G. F. Rouse (National Bureau of Standards, Washington, D.C.) have measured the amount of helium which is absorbed by a nickel cylinder used as a negative probe in a hot-cathode arc discharge. At −100 volts one ion in three thousand will be absorbed by the probe. By heating a layer of nickel sputtered on to the glass wall, a large fraction of the helium can be recovered, whereas the gas which is driven into the probe is less easily liberated.

A report of an investigation of the audio- and radio-frequency oscillations produced by a hissing arc discharge in air, oxygen and nitrogen at atmospheric pressure was given by T. B. Jones and B. H. List (Johns Hopkins University). The former oscillations manifest themselves in arc voltage, current and sound, and occur at random; they are caused by the motion of the anode spot. The latter occur in narrow bands between 1 and 60 Mc./s. and are thought to be associated with the motion of positive ions in the plasma.

L. B. Loeb (University of California, Berkeley) presented R. P. Stein's measurements of the electric field in an abnormal glow discharge in air at pressures between 10^{-2} and 10^{-1} mm. of mercury and current densities of the order of 10^{-5} amp./cm.^{2} by observing the deflexion of a transverse 10-kV. electron beam. The field decreases nearly linearly with the distance from the cathode in agreement with Aston's results. Fields down to a few volts per cm. can be measured. Loeb also reported on E. J. Lauer's work on the discontinuous corona discharge between a positive platinum wire and a coaxial nickel cylinder in hydrogen and argon at pressures between 10 and 400 mm. of mercury. The discharges were initiated by α-particles shot axially through the gas near the nickel cylinder. The analysis of the current pulses shows that in hydrogen the liberation of secondary electrons at the cathode is essentially due to a photo-effect with a coefficient γ of the order of 10^{-3} to 10^{-4}. The contribution by positive ions is negligible. Small amounts of oxygen increase the photon absorption and reduce the secondary coefficient. In argon, photons do not contribute to secondary emission; only low-energy A_2^+ ions are effective, yielding a coefficient of about the same magnitude. The observed decrease of the coefficient with increasing pressure is probably caused by back diffusion of electrons in the low field of the cathode.

A paper by M. Menes and L. H. Fisher (New York University) gave an account of how they have measured the formative time-lag of a discharge on positive metal points (0·07–0·3 mm. radius) in dry air irradiated with ultra-violet light, the negative electrode being a plane at a distance up to 1·5 cm. They found that when the pressure was increased from 30 to 700 mm. of mercury, the time-lag at threshold potential decreased from 1 to about 0·1 μsec., depending only slightly on the radius, distance and illumination. This and the small lag indicate that the multiplication processes leading to the starting of a corona discharge are controlled by the gas.

The starting of a discharge between plane metal electrodes 1–4 cm. apart at pressures of less than or equal to 1 μ mercury and frequencies of 30–90 Mc./s. has been investigated by A. J. Hatch and H. B. Williams (New Mexico College), and they have observed that the starting field decreases with decreasing frequency as known for electrodeless discharges—until the cut-off frequency is reached. An avalanche of secondary electrons supplied by the electrodes is thought to initiate the discharge. However, when a strong field is quickly applied and then slowly lowered, a second field/frequency curve is obtained which lies above the first; this branch seems to depend on surface conditions and gas content of the electrodes.

A. von Engel (University of Oxford) dealt with the growth of an electrodeless discharge in high-frequency electric fields at very low pressure, based on work by G. Francis. From oscillograms of the discharge current and from theory, it is concluded that initially an avalanche of secondary electrons from the glass wall is formed, rising exponentially with time; then positive ions are produced in the gas, reducing the speed of impact of electrons on the walls and thus secondary emission. Finally, the ion concentration becomes so large that the amplitude of electron oscillation is reduced. The losses to the wall are ascribed to self-repulsion. A. VON ENGEL

COLOUR VARIATION IN THE BRUSH-TONGUED LORIES

AT a meeting of the British Ornithologists' Union held in the Zoological Society's lecture room on November 22, Dr. A. J. Cain, lecturer in zoology in the University of Oxford, gave a lecture on colour variation in the brush-tongued lories of the genus *Trichoglossus* inhabiting Australia and the islands of the South West Pacific, where the commoner forms are known as the blue mountain lory and the coconut lory. With specimens kindly loaned from the Reference Collections in the British Museum and by means of attractive Kodachrome slides, Dr. Cain showed that most of the random variation and distribution described by some authors for these birds could be explained satisfactorily in the light of modern evolutionary ideas.

Brightly coloured brush-tongued lories with striking orange and blue or scarlet and black undersides in almost endless variation live in flocks in open wooded areas, on islands from Bali to New Guinea with the Solomon Islands, and from Eastern Australia to the Caroline Islands. Much of the variation is correlated with local climate; but *Trichoglossus hæmatodus weberi* from Flores is a subspecies which is green all over, lacking the red and black underparts of *Trichoglossus hæmatodus mitchelli* from Bali and Lombok or the green and yellow underparts of *Trichoglossus hæmatodus capistratus* from Timor.

In Flores this subspecies of *Trichoglossus* lives quietly in the woods, clad in the sombre jungle green uniform of the forest dweller which seeks its food far and wide in the presence of its enemies. It has apparently changed its ecological niche.

In contrast, there lives on Ponape Island in the Carolines *Trichoglossus hæmatodus rubiginosus*, separated by nearly a thousand miles from its nearest relatives in the Solomon Islands. Except for its tail, it is a uniform, dull blood-red colour, with soft, silky plumage unlike the hard features of all the other forms. This subspecies meets no visual predators in its island and needs no recognition marks between friends, for there are no other lories or parakeets with whom confusion can occur. Consequently it has abandoned the usual coloration in the forms, which is cryptic dorsally and variegated ventrally.

VACUUM PHYSICS

FUNDAMENTALLY, the study of high vacuum is a branch of physics. However, following war demands, there has been a rapid development in recent years of large-scale and industrial applications of vacuum processes, and a new branch of engineering, in which high-vacuum technique dominates, has been developed. This new development, together with the considerable improvements in vacuum technique and equipment which have accompanied it, is not as widely known to research workers in the various branches of science as it deserves. The Midland Branch of the Institute of Physics is therefore to be congratulated on having taken the initiative in arranging an exhibition of modern vacuum equipment and a symposium on vacuum physics during June 27–28, 1950. The proceedings of the meeting have now been published by the Institute of Physics in a special supplement of the *Journal of Scientific Instruments**.

The exhibition and symposium were held in the University of Birmingham, at the invitation of Prof. M. L. Oliphant, and some two hundred members of university, government research and industrial laboratories attended. A wide range of pumps, gauges and associated equipment was exhibited by the leading manufacturers of vacuum equipment in Great Britain. The exhibits were attractively laid out and included many working models arranged for actual demonstration. The Physics Department of the University of Birmingham put on show some pieces of vacuum equipment of a specialized nature which had been developed to meet the requirements of the nuclear research programme carried out in that Department, and several conference members were given the opportunity of inspecting the large particle accelerators under construction in the Department. Altogether, eleven papers, each of which was followed by a lively discussion, were read.

The proceedings of the symposium may be divided into three sections which deal with the production and measurement of high vacua, leak detection and modern applications of high-vacuum processes respectively. In the first section, D. R. Goddard discusses in rather a general manner the

* *J. Sci. Instr.*, Supp. 1 (London: Institute of Physics, 1951; 15*s.*).

modern forms of the distinct classes of vacuum pump—the mechanical and the vapour pump. The requirements governing the choice of a particular pump are considered and, in particular, the capacity, ultimate pressure (in the case of the vapour pump also the backing pressure) and characteristics are discussed. The paper concludes with the remark that, though the construction of modern pumps is extremely simple, many seem to be designed on a hit-or-miss basis and that more investigation is needed to elucidate the mechanism of the pumping action. Most physicists will, undoubtedly, heartily agree with this conclusion.

The two other papers in this first section are by T. S. Miller on the design of industrial vacuum systems, and by W. Steckelmacher on vacuum gauges. The latter is a brief but comprehensive review of methods of measuring pressures below 10 mm. of mercury in which the limitations of the conventional gauges for accurate measurement are carefully examined.

In the second section the general principles of leak detection are reviewed by J. Blears and J. H. Leck. Emphasis is placed on the simpler methods. The mass-spectrometer leak detector which has been extensively developed both in the United States and in Great Britain is now an extremely sensitive and efficient leak detector, and the cold-cathode instrument described by C. J. Milner, of the British Thomson-Houston Co., Ltd., has the advantages of robustness, long life and the avoidance of refrigerated traps. The use of the mass spectrometer, not as a leak detector but for analysing the residual gases in normal dynamic systems, is discussed by J. Blears in a separate article.

The third section, dealing with modern applications of vacuum processes, contains papers on large-scale vacuum dehydration, freeze drying, vacuum coating plant and techniques, the vacuum melting and sintering of metals and a description of the vacuum system of the Birmingham proton synchrotron. These illustrate the many and varied industrial and research developments made possible by improvements in vacuum technique.

Altogether the supplement describing the symposium forms an excellent report on the progress made during the past ten years, and should help considerably to stimulate further research on the basic problems of creating and measuring vacua, in addition to bridging the gap between the standard text-books and recent publications in the specialized periodicals.

S. Weintroub

BRITISH GUIANA FOREST DEPARTMENT

REPORT FOR 1948

THE annual report for 1948 of the British Guiana Forest Department* has only been recently received and is in consequence rather out of date; but it discloses a curious position for a Forest Department to be in. From the introductory notes it is difficult to gather the real forest policy of the Colony; for the different parties who appear to be organizing the forest policy seem to have conflicting aims. In any event, the report commences with the remark of the Conservator: "I regret to have to report that during the whole of 1948 the work of the Department has been paralysed owing to the failure to fill staff vacancies. At such a critical period in the development of our forest resources, this state of affairs has been doubly unfortunate".

From this report it is seen that the Evans Commission visited the Colony in the latter part of 1947 with the view of assessing the possibility of settlement of the under-populated areas of the Colony. Particular attention was paid to the development of timber resources. Experts were brought in, and the Colonial Development Corporation suggested the formation of a British Guiana Forestry Corporation, which was set up under the leadership of a former chief conservator of forests of Burma. The Colonial Development Corporation has acquired important forest concessions in the Colony, and a short-term option has been also given over a large area of forest in the north-west district to Canadian interests. Considerable building development is being considered in the Colony, and this will require large amounts of timber.

At a time when the world demand for timber is so great, it seems a great pity that the development of this very important resource of the Colony was not done years ago. The Forest Department was formed in British Guiana in 1925, but it never had more than a handful of staff. Yet there was all this work waiting to be done by professionally trained foresters, who were available to be taken on to the staff at the time of formation and during the following fifteen-year period prior to the outbreak of the Second World War.

* British Guiana Forest Department. Annual Report for 1948. (Georgetown: Forest Department, 1951.)

ORGANIZATION OF ATOMIC ENERGY WORK IN BRITAIN

THE January issue of *Atomic Scientists News* contains a symposium of the views of some leading scientific men on the organization of work on atomic energy in the United Kingdom. The remarks are based on Lord Cherwell's speech in the House of Lords, on July 5, 1951, in which he advocated transfer of the responsibility for work on this subject from the Ministry of Supply to a special organization more flexible than the normal Civil Service system.

The main points of Lord Cherwell's speech are given, and in commenting on them Prof. M. W. B. Skinner and Sir George Thomson agree with Lord Cherwell so far as production is concerned. While, however, he agrees that it was a mistake to put atomic energy under Civil Service control in 1946, Prof. Skinner is dubious as to whether it would now be advantageous to take atomic energy out of the Civil Service and place it under some other organization; he believes that considerable thought should be given to the best form of organization for obtaining clear decisions on technical policy and for the most efficient implementation of the work. Sir George Thomson also doubts whether Civil Service restrictions are now such a serious matter for a going concern as they were in early days at Harwell, and in his tribute to the good work at Harwell in spite of such handicaps, he supports what has recently been said by Sir John Cockcroft elsewhere. Neither believes that scientific freedom in Britain is imperilled by State planning; but Sir George considers that, so far as security is

concerned, a large firm, with the assistance of the relevant government services, would be at least as safe as the present organization. He thinks that security troubles have come rather from failures in detection than from not being ruthless enough in acting on evidence less than legal proof.

Prof. H. S. W. Massey concurs in these views. Most physicists think that Harwell has succeeded to a remarkable extent, but that development would best be carried out by a body of the corporation type retaining the maximum possible freedom and initiative. It is a very different matter, however, to change an established system which is working well, and Prof. Massey thinks that suggestions that a corporation could tighten up security by decreasing security of tenure or restricting civil rights, such as travel, are particularly ill-advised.

A statement made by Prof. M. H. L. Pryce represents the views of scientific men directly concerned with atomic energy work. There appears to be general agreement in the atomic energy establishments that certain features of the present organization, such as the rigid staffing system, are frustrating and should be changed; but a strong body of opinion holds that the situation can be remedied within the Civil Service by giving greater autonomy to the various establishments. This view is particularly strong in the production establishments, whereas those more closely concerned with the research side tend to share the general outside view of the unalterable inflexibility of Civil Service organization. The popular view that the Civil Service is inefficient is not strongly held at Harwell, and it was forcibly put to Prof. Pryce that this view is ill-informed and made by those without experience of the essential structure of large organizations. Prof. Pryce, moreover, makes an important point about the publicity policy of the Ministry of Supply. Few people know of the real achievements at Harwell, of which many sections of the Establishment should justifiably feel proud. Not only is there, accordingly, no feeling of pride in the Establishment, but also potential recruits into the atomic energy field are not attracted; and the belief, fostered by the Ministry's attitude, that most of the work at Harwell is secret, deters others from joining. Opinion, however, in the establishments appears to be crystallizing in favour of remaining in the Civil Service, and this tendency has been strengthened by Lord Swinton's comments in the House of Lords on security conditions and the possible loss of civil rights and fears of arbitrary dismissal under a new system.

COMETS AND THEIR ORIGIN

THE presidential address to the British Astronomical Association[1], delivered by Dr. G. Merton on October 31, was on the subject of "Comets and their Origin". Dr. Merton gave a short historical survey of the subject, followed by a description of the different parts of these bodies, their composition, their appearances more particularly as they approach perihelion, the diversity in their orbits and the peculiarities exhibited by certain comets regarding sudden increases in brightness, etc., and then he proceeded to his main thesis on the origin of comets. Before considering some of the older theories, he referred to two modern ones which depend upon the passage of the sun through a cloud of interstellar dust, or upon the debris of an exploded planet, this debris—or a very small fraction of it—afterwards becoming a cloud of comets. Neither theory is really new, but important details have been worked out within the past few years and differ from many of those previously suggested; there are differences in other ways as well. The first of these, by R. A. Lyttleton, has already been mentioned in *Nature*[2], and so in this article it is only necessary to refer to the other that appeared a little later, namely, that due to J. H. Oort[3].

Oort's theory postulates the explosion of a planet between the orbits of Mars and Jupiter, the fragments with approximately circular orbits around the sun becoming minor planets and meteors. Portions with elliptical orbits which approached Jupiter or other planets were subjected to perturbations which, taken on the whole, increased the major axes of their orbits, and by far the greater part of the debris, thrown into hyperbolic orbits, was lost to the solar system. About 3 per cent of the debris moved in elliptical orbits with very large major axes—from about 25,000 to 200,000 astronomical units—and this portion formed the outer clouds of comets which have supplied the solar system with these bodies since the explosion took place, and will continue to do so for a long time, as the estimated number of comets is of the order of two hundred thousand million. On the assumption that the exploded planet had a mass about that of the earth and also that 3 per cent of it formed the outer cloud, the average mass of a comet would be about ten thousand million tons; but the above figures merely denote the order of number and mass.

Assuming that the cloud had a random distribution of directions with respect to the sun, a small proportion of the comets would cross a sphere of radius about two astronomical units, the sun being at its centre; and van Woerkom, an associate of Oort at Leyden Observatory, has shown that such comets would be forced into hyperbolic orbits and ejected from the solar system or converted into short-period comets. Perturbations by the stars are responsible for supplying new comets to this small inner sphere.

The details of the theory are very fully dealt with in Oort's original paper, but in the limited space allotted for Dr. Merton's address it was impossible to explain all these. (It may be remarked that the explosion of a planet with the subsequent production of minor planets and meteorites have been dealt with by W. H. Ramsey and M. J. Lighthill in some papers which appeared in the *Monthly Notices of the Royal Astronomical Society*, references to which have been made in *Nature*[4], though it is admitted that the complexity of the problem prevents a complete quantitative treatment.) Towards the end of his address Dr. Merton referred to some of the theories of the origin of the periodic comets: the capture theory, which postulates a close approach of long-period comets to some of the giant planets the perturbations of which turned them into relatively short-period comets; and the theory that they were ejected by the planets or even by the sun. As he pointed out, the great difficulty about all ejection theories is the absence of any positive evidence to support them, especially as the processes of ejection are supposed to be still going on.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Polarization of Starlight

The evidence for the polarization of the light from many stars has accumulated since Hiltner's first observation of the effect[1]. Owing to the correlation of the effect with interstellar absorbing medium, it now seems certain that the explanation must be found in an anisotropy of this medium. The direction of the polarization is variable from star to star, shows a regional correlation, and a general preference for the electric vector to lie in the galactic plane. The magnitude of the effect (up to 12 per cent plane polarization) would be accounted for by a 5 per cent difference in the extinction coefficient in the two planes of oscillation[2].

Previous theories have aimed at explaining this anisotropy by supposing elongated magnetic dust particles to be partially aligned by magnetic fields[2,3]; but there has been no other evidence for fields of such strength (the existence of which is questionable on theorctical grounds), or for the implausible physical properties assumed for the dust.

A direction in space is given also by a process of double streaming, such as by dust particles penetrating through the tenuous galactic gas. Such relative velocities can be damped out only very slowly, and must be regenerated frequently through the acceleration of the gas by pressure gradients, which have a very much smaller effect on the dust. Indeed, it seems unlikely that much dust exists which does not possess a velocity relative to the surrounding gas far exceeding the thermal velocities of the gas molecules; that is, the motion of the dust is generally supersonic.

The spin of elongated dust particles can be calculated when it is principally due to impacts with gas molecules at supersonic speeds. All such impacts impart angular momentum about lines lying in a plane normal to the relative velocity. It can then be shown that elongated particles will spin with their long dimension remaining mainly in planes which all contain the direction of the relative velocity. Such a motion implies an anisotropy of the probability distribution of the instantaneous directions of the particles. The maximum effect which can result is that the summation of the projected lengths of all particles in the direction of the velocity is $\pi/2$ times as great as that in a normal plane. The observed effect does not require such a high degree of alignment.

In contrast with the magnetic theories, the present process affects all those particles which are elongated enough to cause polarization, irrespective of their other physical properties.

It seems likely on dynamical grounds that the velocities of interpenetration which occur in the galaxy have their major component in the direction normal to the galactic plane; this would agree with the observed preference of the electric vector of the light for this plane.

A fuller account of this work will be given in the *Monthly Notices of the Royal Astronomical Society*.

T. Gold

Cavendish Laboratory,
Cambridge. Dec. 16.

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Crystal Structure of 3.4 ; 5.6 Dibenzphenanthrene

The structure of 3.4 ; 5.6 dibenzphenanthrene (Fig. 1) is of interest because steric effects prevent the molecule from assuming a planar configuration[1]. In spite of its non-planarity, the substance has the properties of an aromatic hydrocarbon.

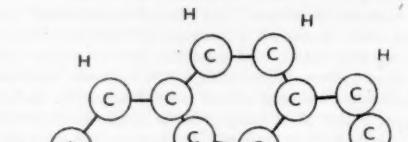

Fig. 1. Sketch of the model of 3.4 ; 5.6 dibenzphenanthrene, showing the nature of the distortion

3.4 ; 5.6 Dibenzphenanthrene crystallizes in two modifications[2]. Both are monoclinic, one of space group $P2_1/a$, the other $A2/a$. The existence of the simpler form was discovered after the investigation was well advanced.

We have determined the molecular shape of the $A2/a$ modification using X-ray crystallographic methods. Due to the complex molecular packing, only one projection could be used. Sufficient refinement has been obtained, however, to show the molecular distortion.

The $A2/a$ form of 3.4 ; 5.6 dibenzphenanthrene has the unit cell dimensions: $a = 26{\cdot}17$ A.; $b = 8{\cdot}94$ A.; $c = 19{\cdot}57$ A.; $\beta = 105{\cdot}1°$.

The systematic absences do not permit distinction between space groups Aa and $A2/a$; but Wilson's method[3,4] indicated a centric distribution of intensities. There are twelve molecules per unit cell. (Density measured 1·264, calculated 1·253.) The asymmetrical crystal unit is one and a half chemical molecules. This type of distribution requires that

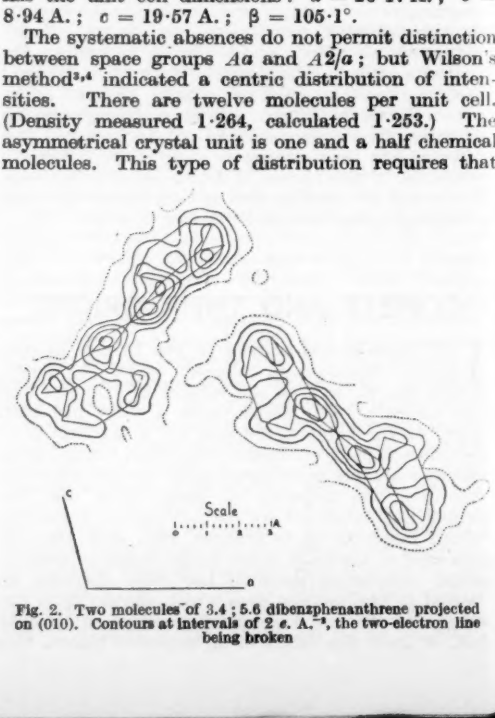

Fig. 2. Two molecules of 3.4 ; 5.6 dibenzphenanthrene projected on (010). Contours at intervals of 2 *e*. A.$^{-2}$, the two-electron line being broken

four of the molecules in the unit cell make use of their two-fold symmetry axes.

The analysis of the structure was difficult due to the distorted configuration of the molecule and to the large size of the asymmetric unit (33 carbon atoms). The molecular positions were found by trial-and-error methods. The x- and z-co-ordinates of the carbon atoms were refined by electron density and difference ($F_o - F_c$) projections down the short b-axis. The final electron density map of two molecules is shown in Fig. 2. The contours are at intervals of 2 e. A.$^{-2}$. The atomic co-ordinates shown are the ones obtained from the thirteenth difference synthesis. There is much overlapping of atoms in the projection; but the distortion of the molecule is visible. The y-co-ordinates of the carbon atoms were found by trial and error and are less accurate. The degree of refinement of the structure does not justify the measuring of interatomic distances. However, the results indicate that the closest approach of non-bonded carbon atoms in the molecule is approximately 3·0 A.

The molecule departs greatly from a coplanar configuration. It appears that the steric effect has resulted almost entirely in distortion from a planar arrangement with little change in the hexagonal form of the benzene rings.

We are indebted to Prof. R. Pepinsky, of Pennsylvania State College, for the calculation of some of the Fourier syntheses using the X-ray Analogue Computer. The crystals used in the investigation were kindly supplied by Prof. J. W. Cook, of this University.

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Sept. 10.

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Molecular Dimensions of Phenazine

While good agreement has recently been reported[1,2] between observed and calculated bond-lengths in aromatic hydrocarbons, not many results are available for a similar comparison in the heterocyclic series. Because of the difficulties which beset the calculations of bond-orders in heterocyclic molecules[3], a comparative study of the series anthracene – acridine – phenazine should be particularly suitable for an investigation of the effect of introducing hetero-atoms into an aromatic system. The crystal structure of anthracene has been fully investigated[1], and preliminary results for one of the forms of acridine have been published[4]; the results of a two-dimensional analysis of phenazine are reported here.

The crystallographic constants of phenazine are:

$a = 13{\cdot}22 \pm 0{\cdot}01$ A.; $b = 5{\cdot}061 \pm 0{\cdot}005$ A.; $c = 7{\cdot}088 \pm 0{\cdot}007$ A.; $\beta = 109° 13' \pm 15'$; space group, $P\,2_1/a$; $N = 2$; molecular symmetry, $\bar{1}$.

These data agree well with those previously published[4].

We determined the first set of signs of the zonal reflexions by using the Fourier transform[5] of phenazine[7], which was calculated for a planar model with appropriately weighted atoms at the corners of regular hexagons of side 1·40 A. The success of the transform technique, in spite of the obvious approximations, may be judged from the data in the accompanying table.

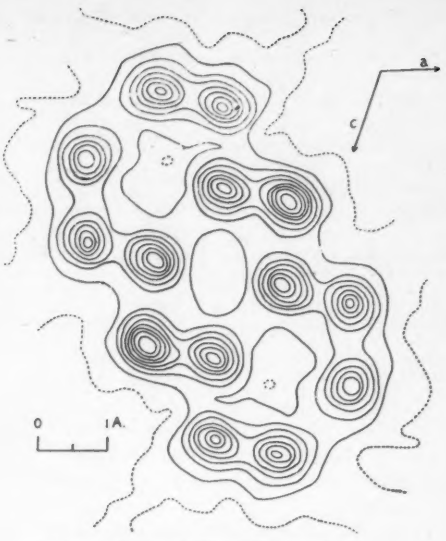

Fig. 1. Electron density projection on (010)

Zone	No. of spectra observed	No. of correct signs from transform
$h0l$	106	96
$hk0$	45	39
$0kl$	23	22

The Fourier projection on (010) with the signs determined from the transform showed full resolution of the seven atoms in the asymmetric unit; this projection was refined by successive Fourier summations, and the final u, w co-ordinates were corrected for termination of series error by one ($F_o - F_c$) synthesis[8]. The v co-ordinates were obtained by applying the method of least squares[9] to the $hk0$ and $0kl$ spectra, using the final u, w co-ordinates and assuming the molecule to be planar. The values of the discrepancy factor, R, for the three zones are: $h0l$: 16 per cent; $hk0$: 16 per cent; $0kl$: 12 per cent.

Fig. 2 (*a*) shows the observed bond-lengths and bond-angles, while in Fig. 2 (*b*) we quote figures calculated

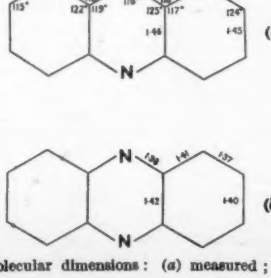

Fig. 2. Molecular dimensions: (*a*) measured; (*b*) calculated

by Dr. B. Pullman[10] using the method of molecular orbitals.

The structure is being refined by three-dimensional analysis.

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Department of X-Ray Crystallography,
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Rehovoth, Israel. Sept. 15.

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Dielectric Properties of some Clathrate Compounds of Quinol

The term 'clathrate compound' has been suggested for that type of molecular complex in which molecules of one compound are held in cavities in the crystal structure of another. Whether a compound can be entrapped in a particular clathrate structure is determined by the physical dimensions of its molecules. Quinol forms clathrate compounds with a number of elements and compounds, and X-ray crystallographic studies of some of these have been made (see, for example, ref. 1). The β-quinol crystal structure contains cavities approximately spherical in shape, the ratio of the number of available cavities to quinol molecules being one to three.

It seemed likely that clathrate compounds of quinol and polar molecules might possess interesting dielectric properties which would provide evidence regarding the freedom of orientation of the polar molecules in the cavities. A number of such compounds were therefore prepared and, after powdering, pressed into disks suitable for measurement. It has been previously reported[2] that quinol specimens prepared in this manner give dielectric absorption at low frequencies, which decreases with time. In the accompanying table the values of the relative permittivity (ε') listed at 50 kc./s. are those obtained after this low-frequency absorption has decreased to such an extent that the relative permittivity has reached a constant value. For the pure quinol, ε' is only slightly in excess of the square of the refractive index[1] ($n_D = 1{\cdot}63$), indicating the absence of any strong absorption at frequencies up to those in the visible region. The clathrate compounds give larger values of ε', however, although the refractive indices are similar to those of pure quinol. For the first three clathrate compounds shown in the table, the enhancement of the relative permittivity is nearly proportional to the square of the dipole moments of the polar molecules, which indicates that it is the orientation of these molecules in the structural cavities which results in the enhancement of ε'.

It was expected that such a mechanism would give rise to a region of energy absorption at ultra-high radio-frequencies. As can be seen by reference to the table, the appreciable loss factors measured at 8,600 Mc./s. for the methanol, hydrogen cyanide and sulphur dioxide compounds are an indication of this. The peak in the absorption is evidently at higher frequencies, however, since the values of ε' at 8,600 Mc./s. are either the same as, or only slightly lower than, the values at 50 kc./s.

Quinol compound	Dipole moment of polar molecule (ref. 3) (in *D* units)	ε' at 50 kc./s.	ε' at 8,600 Mc./s.	ε'' at 8,600 Mc./s.
Quinol cryst. from alcohol		2·9	—	—
Quinol cryst. from water		2·8	2·8	<0·002
Clathrate compound with:				
Methanol	1·66	4·6	4·6	0·14
Hydrogen sulphide	1·1	3·4	3·2	<0·002
Hydrogen cyanide	2·6–3·0	9·2	8·2	0·57
Methyl cyanide	3·4	3·1	3·1	<0·003
Sulphur dioxide	1·7	3·9	3·7	0·015

Although the dipole moment of methyl cyanide is larger than that of any of the other polar compounds tested, its clathrate compound with quinol shows only a small enhancement of the relative permittivity. This could be due to the larger size of the methyl cyanide molecules, compared to the other compounds, which reduces their freedom of orientation in the crystal lattice. The X-ray data[1] indicate that methyl cyanide causes a considerable distension of the quinol crystal lattice, and this suggests that the molecules are held more firmly in position. A similar explanation may account for the fact that the value of ε' for the sulphur dioxide compound is lower than that to be expected from the dipole moment; X-ray data indicate that the sulphur dioxide compound also possesses a slightly distended lattice.

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National Standards Laboratory,
Commonwealth Scientific and
Industrial Research Organization,
Australia. Aug. 23.

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Solid Films on Electropolishing Anodes

To explain the characteristic avoidance of etching on an electropolishing anode, Hoar and Mowat[1,2] postulated the formation upon it of a compact solid film, dissolving at its outer surface as fast as it is formed anodically from the metal. We believe we have now obtained direct evidence of the presence of such a film during the electropolishing of copper and α-brass anodes in the 50/50 v/v orthophosphoric-acid/water bath.

A conventional electropolishing arrangement of a horizontal sheet anode with a similar cathode 1 in. above it was used. Through holes in the cathode, mercury could be introduced from a microburette so that it fell upon the anode in small drops from the tip of the burette, ¼ in. above the anode. The following observations were made.

(1) Mercury was dropped on to a copper or α-brass anode that was etching anodically, with 0·9 V. across the cell. The drops wetted the surface immediately, usually in less than a second, and then spread over it. Spreading continued steadily while the specimen

was left in the bath, either anodically etching or with the current shut off, but ceased as soon as the specimen was removed and washed, doubtless because the remaining unamalgamated copper or brass surface quickly became covered with the usual air-formed 'invisible' oxide film, not penetrated or displaced by liquid mercury. Spreading also ceased immediately if the specimen was subjected to electropolishing conditions as below.

(2) Mercury was dropped on to a copper or α-brass anode that was *polishing* anodically, with 1·8 V. across the cell. The drops either: (*a*) did not wet the surface, but slowly rolled over it and off the specimen, after being in contact with it for periods of up to several minutes; (*b*) became immobilized on the surface, which was then wetted by mercury over a small area that did not spread while the anodic current flowed, but that began to spread, as on an etching specimen, within a second or so after the current was switched off; (*c*) if very small, sometimes became immobilized on the surface, but gave no visible wetting or amalgamation.

In cases 2(*b*) and (*c*) the metal surrounding each drop could be electropolished away for long periods, so that the specimen developed hillocks under the drops. In case (*b*), specimens removed from the bath while still anodically polishing showed immediate drop-spreading when afterwards etched.

It is well known that mercury readily wets clean, film-free solid metals, but does not wet non-metallic solids. We conclude that a continuously forming and dissolving compact solid film, absent during etching, is present on the surface of copper and α-brass electropolishing anodes in the phosphoric acid bath. Observation 2(*b*) above is readily explained, since the mercury drop may sufficiently reduce the current-density on the metal vertically below the overhang of the drop so that the film can dissolve locally while anodic polishing conditions are generally maintained; the film dissolves generally as soon as the current is switched off. Alternatively, (2*c*), the drop may sometimes, by a lucky impact, displace all electrolyte from an area between it and the solid film (which there remains unchanged, shut off both from anodic action and from the electrolyte) and, owing to its small size, give insufficient reduction of current-density below the overhang to allow film dissolution there.

The chemical nature and the thickness of the solid film are, of course, not indicated by these simple experiments; the film may be oxide, hydroxide or (in the present case) phosphate, and it may be of thickness between a unit cell up to the nearly visible.

Further investigations of the surface of polishing anodes are in progress in this laboratory; they will be published in detail elsewhere.

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T. W. Farthing

Department of Metallurgy,
University of Cambridge.
Sept. 28.

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Use of a Photomultiplier to Measure Intensities in the Vacuum Ultra-violet Region

The difficulties of photographic photometry in the vacuum ultra-violet region have stimulated a number of workers to adapt the *RCA* type photomultipliers for use in this region[1]. We have successfully used an *E.M.I.* type 5060, eleven-stage tube.

The spectrograph is a one-metre, normal incidence type equipped with a grating having 14,400 lines per inch, giving a dispersion at 1200 A. of 0·053 mm. per angstrom unit. The grating can be rotated about a vertical axis by an external control. With a spectrograph slit 0·048 mm. wide, a slit 0·025 mm. wide in front of the photomultiplier cathode is sufficient to produce a large response (8 microamp. at λ 1215·6) when the cathode is coated with a suitable fluorescing agent. The source used in preliminary experiments has been a direct-current capillary arc in hydrogen at a current density of about 5 amp. per cm.[2].

Under these conditions, the width of a narrow, perfectly focused spectrum line at half maximum intensity should be about 0·9 A. and at maximum intensity about 0·45 A. Observations on the profile of λ 1215·6 show a width at half maximum intensity of 0·95 ± 0·1 A. This indicates that focusing errors are too small to prevent true intensity maxima being obtained.

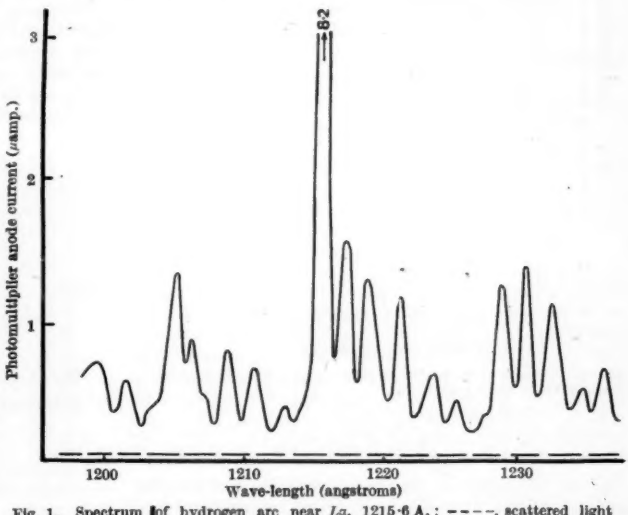

Fig. 1. Spectrum of hydrogen arc near $L\alpha$, 1215·6 A.: ----, scattered light response with 'clean' window

A section of the spectrum of the hydrogen arc, including λ 1215·6, is shown in Fig. 1. This was obtained by manual adjustment of the grating, deflexions of the galvanometer in the photomultiplier anode circuit being observed at intervals of 0·4 A. Pending the installation of photographic recording, observations of line intensities are made by setting the grating manually to the maximum galvanometer deflexion. Experience shows that the variation is 2–3 per cent, which is about the limit of manual control of the arc current. Fluctuation in the photomultiplier dark current is unobservable.

Approximate relative efficiencies of various fluorescing agents, at 1215 A., are indicated in the accompanying table.

Comparative Efficiencies of Fluorescing Media at 1215 A.

Substance	Relative response
Apiezon oil *B*	100
Apiezon grease *L*	100
Zinc silicate on *L* grease	100
Calcium tungstate on *L* grease	50
Magnesium α-tungstate on *L* grease	50
Calcium tungstate alone	10
'Clean' cathode	10

It would appear that calcium tungstate and magnesium α-tungstate are of little use with the 5060 tube, the maximum response of which is at 4800 A.; zinc silicate, which Tomboulian and Pell[2] found useless, is, in our case, as efficient as oil or grease. The response with a 'clean' cathode is presumably due to fluorescence excited in the 'Pyrex' glass, as a line spectrum is seen and the scattered light background (shown in Fig. 1) is negligible.

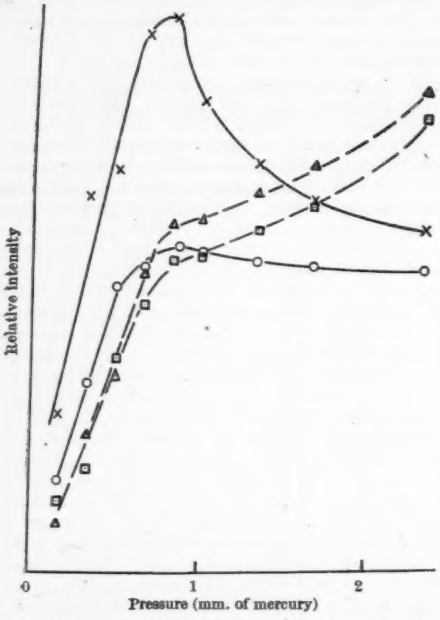

Fig. 2. Changes in intensities of atomic and molecular lines as discharge pressure is varied :

H, ——, { ×, λ 1025, × 1 ; ○, λ 1215, × 0·05
H_2, – – – –, { □, λ 1160, × 1 ; △, λ 1221, × 0·5

As an example of the type of observations the photomultiplier makes possible, the intensity variations of the first two Lyman series lines and of two molecular lines are shown in Fig. 2, for different discharge pressures. These measurements were made in less than an hour. The different behaviour of the atomic and molecular lines is very marked, and, in fact, was used to identify λ 1025 as $L\beta$ and later to decide that $L\gamma$ did not appear among lines at 972 A.

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Dec. 5.

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A Stroboscopic Mercury Vapour Light Source

Beeson and Webb[1] have recently described a xenon discharge lamp for optical systems which is capable of either continuous or flash operation.

A very simple mercury vapour lamp for use as a stroboscopic light source in a photoelastic polariscope has been developed in this Laboratory. The lamp is also capable of giving single flashes of 10 microsec. duration or less, which are of sufficient intensity for photographs to be taken.

It is a simple U-tube of 1½ mm. internal diameter except for a length of about 1 cm. in the centre of the horizontal portion of the U, where the diameter is 2½ mm. Tungsten electrodes are brought into the U through the open ends and carry the current into the mercury. The flashes occur across a vapour gap of about 5 mm. length formed by the action of a small heater coil (about 30 watts) wound on the horizontal part of the tube. The electrodes carry small glass beads which partially close the tube, thereby damping out pulsations of the mercury and steadying the position of the gap; the open ends of the U are enlarged to act as reservoirs of mercury. The voltage across the lamp and an ignitron which acts as a switch is 4·7 kV. With very clean mercury the lamp fires well, though at repetition frequencies exceeding about 20 per sec. it may miss occasionally.

The lamp now in use has been developed by S. L. Harris, and is a simplified and improved version of a lamp devised by C. H. Wan. The development of this lamp has been part of a project carried out with the financial support of the Department of Scientific and Industrial Research.

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Relation of Volume of Bubble to the Diameter of the Orifice at which it is Formed

The theoretical value of the ratio of the volume of a bubble to the diameter of the orifice at which it is formed is 0·231 cm. for air–water at 20° C., if the plane of the orifice is horizontal.

Datta, Napier and Newitt[1] have carried out a very thorough series of investigations in which they found a value for this ratio centring about 0·33 cm. at slow rates of formation. They used orifices constructed by grinding square the ends of glass capillary tubing of several internal diameters between 0·022 and 0·519 cm. The volume of bubbles formed at a given size of orifice decreased with increasing rate of formation to a minimum value and then increased, until a random size distribution set in.

By blowing bubbles at a very slow rate, we have been able to observe a further variation in this ratio at very slow speeds. Our orifices were constructed of glass capillary tubing with diameters from 0·0131 to 0·4744 cm. We obtained a value of the ratio

$\frac{\text{volume of bubble}}{\text{diameter of orifice}}$ of 0·19 cm. with all except the smallest two orifices, of diameter 0·0131 and 0·020 cm. As soon as the rate of formation of individual bubbles increased to the point where they could no longer be observed to cling momentarily to the orifice, the value of this ratio rose to about 0·26 cm. We believe that it was this effect which prevented observation of the value of 0·19 cm. with the smallest two orifices. This value of 0·19 cm. is very close to that reported by Coppock and Meiklejohn[2] for very slow rates of bubble formation in homogeneous liquids or mixtures of liquids.

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Oblique Reflexion of Radio Waves by Way of a Triangular Path

Fig. 1 is a vertical incidence record from Baker Lake Ionospheric Station, July 19, 1949, 7.30 a.m. C.S.T. It shows, in addition to the regular *h'f* sweep, a pair of traces due to propagation by means of a triangular path as illustrated in Fig. 2.

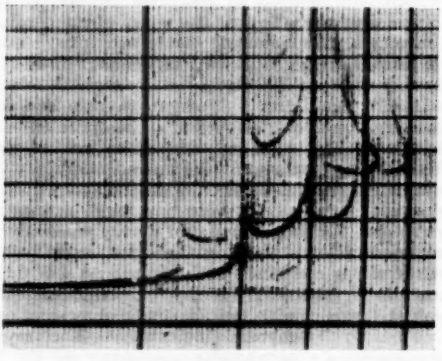

Fig. 1. Vertical incidence record, Baker Lake, July 19, 1949, 7.30 a.m. C.S.T.

Assuming the traces to have been scattered off an E_s cloud at about 110 km. height, the path-length indicates transmission to the *F*-region at an angle of elevation of 51°. The horizontal distance of the cloud from the station was found to be 325 km. The angle of transmission was checked by finding the ratio of the maximum frequency reflected vertically to that reflected obliquely. The same angle of transmission was obtained.

A series of records at 15-sec. intervals was made at the same station on the morning of September 6, 1950. Similar oblique traces were observed, starting at transmission angles of the order of 45° and moving into the vertical sweep and out again. Assuming these traces to be due to horizontally moving clouds

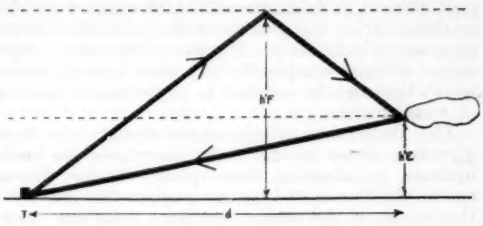

Fig. 2. Oblique reflexion of a triangular path

of E_s, it was possible to calculate their motion at about 330 km. an hour. This is somewhat less than the speeds observed previously on straight oblique returns.

No continuous E_s traces were observed during this period; but as a trace moved into the vertical incidence sweep, a flash from the E_s cloud was sometimes seen.

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Blood Glycolysis during the Alarm Reaction

It is well known that characteristic alterations of the blood sugar occur during the alarm reaction[1]. We thought it interesting to make a closer examination of the carbohydrate metabolism in the course of the alarm reaction. We have investigated the blood glycolysis; this seems particularly suitable for the purpose, because the erythrocytes have *in vitro* a very low consumption of oxygen[2], while they display active processes of anaerobic glycolysis like those that occur in muscular tissue[3].

For our experiments we used albino rabbits of about two kilograms weight. We determined the quantity of sugar in a certain quantity of blood (about 4 ml.) taken from the jugular and which had been previously defibrinated and submitted to continuous shaking in a bath at 37° C. before, and one hour after, incubation; the quantity of glucose consumed was a measure of the intensity of the glycolysis. At different intervals after exposure to stress, we determined the glycolytic power of fresh quantities of the rabbit's blood. The substances used for producing stress were: 4 per cent formaldehyde, 5 ml./kgm., by subcutaneous injection; colchicine, 2 mgm./kgm., by subcutaneous injection; 95 per cent alcohol, 2 ml./kgm., by intraperitoneal injection.

During the alarm reaction, we found that the amount of glycolysis changed with the phase: an initial accentuation, then a depression, and a final reversion to the normal state during the counter-shock phase. The glycæmia produced presented similar changes. The intensity of glycolysis, from the average normal rate of 200 mgm. per 1,000 ml. of blood per hour, can reach, in the phase of excitement, 350–400 mgm. per 1,000 ml. of blood per hour, and fall in the depression phase to 40–50 mgm. per 1,000 ml. of blood per hour.

The phenomena of depression of both glycolysis and glycæmia are most pronounced in very strong stresses, whereas the phenomena of excitement are

predominant in light stresses. Afterwards we wished to demonstrate the genesis of the precocious hyperglycæmia which follows the stress exposure: ergotamine inhibits completely any such hyperglycæmia, which then can be ascribed to a prolonged discharge of epinephrine.

The depression of glycolysis during the hypoglycæmic phase of the shock (in which the carbohydrate metabolism takes place chiefly through anaerobic channels[4]) helps to explain the gravity of this phase of the alarm reaction: thus our experiments show that the animal's chances of surviving are strictly related to its capacity of getting through this phase. A large dose of adrenotropic hormone (12·5 mgm./kgm.) can determine a metabolic state like that provoked by heavy stress, with a subsequent remarkable fall of glycolytic power. Under the same conditions, large doses of cortisone only cause a big increase of glycæmia and of glycolysis.

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Evidence for a Reversible Equilibrium between Actin, Myosin and Actomyosin

In an investigation of the characteristics of the reaction between actin and myosin and adenosine triphosphate, we have found that it is more complicated than hitherto assumed[1,2]. Ultracentrifuge studies were made under various conditions in order to obtain further information on the behaviour of these muscle proteins.

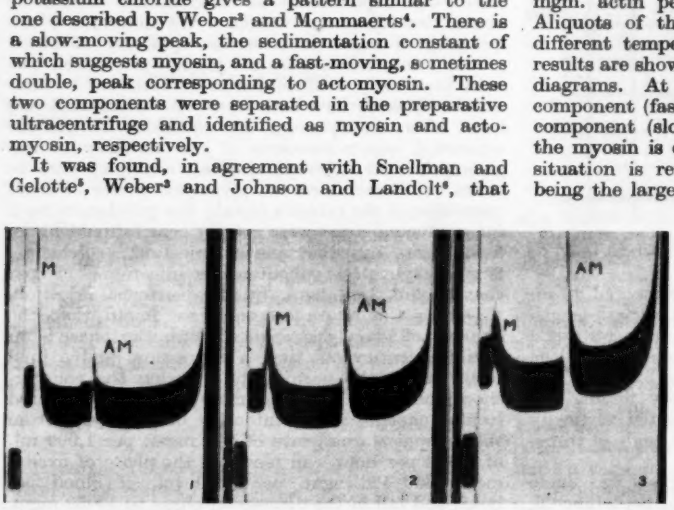
A suitable ratio of actin and myosin in 0·6 *M* potassium chloride gives a pattern similar to the one described by Weber[3] and Mommaerts[4]. There is a slow-moving peak, the sedimentation constant of which suggests myosin, and a fast-moving, sometimes double, peak corresponding to actomyosin. These two components were separated in the preparative ultracentrifuge and identified as myosin and actomyosin, respectively.

It was found, in agreement with Snellman and Gelotte[5], Weber[3] and Johnson and Landolt[6], that the relative amounts of the myosin and actomyosin shown in a sedimentation diagram depended at a given salt concentration on the actin–myosin ratio. If a ratio is chosen which shows both myosin and actomyosin components, progressive additions of actin cause the myosin peak in the diagram to become smaller and finally disappear. To reach this stage, free actin must be in excess. The accompanying table shows the sedimentation constants of the myosin at various actin–myosin ratios. It can be seen that with the increase of actin the sedimentation constant of myosin increases as the concentration of free myosin decreases. This is in keeping with our own observations and those of others (Snellman and Erdös[7], Weber[3]) on the dependence on concentration of the sedimentation constant of myosin.

Temp. at which runs were made	Actin (mgm./ml.)	Myosin (mgm./ml.)	$S_{20,w}$ myosin
11·0° C.	0	1·9	5·27
10·1° C.	0·53	1·9	5·68
7·6° C.	0·90	1·9	5·84
8·3° C.	1·59	1·9	6·13
10·4° C.	2·90	1·9	(6·15)* No free myosin present

* Value obtained by extrapolation to zero concentration.

Actin–myosin mixtures, stoichiometric by the superprecipitation test[8] (that is, there is neither myosin nor actin in the supernatant), unexpectedly showed a myosin component in the ultracentrifuge diagrams. Since the superprecipitation test and the centrifuge runs were made at different salt concentrations and temperatures, this finding may indicate that the combination of the two proteins is a reversible one (actin + myosin ⇌ actomyosin)[9], the equilibrium of which is influenced by temperature and possibly by ionic strength. To test the effect of temperature, actomyosins, stoichiometric in the superprecipitation test, were centrifuged at various temperatures. The following example illustrates the findings. A solution was made containing 3·50 mgm. myosin and 1·65 mgm. actin per ml. in 0·6 *M* potassium chloride. Aliquots of this mixture were then run at three different temperatures in the ultracentrifuge. The results are shown in the accompanying sedimentation diagrams. At 26·5° C. there is a large actomyosin component (fast boundary) and a very small myosin component (slow), showing that the larger part of the myosin is combined with actin. At 4·9° C. the situation is reversed, the slow myosin component being the larger, with only a small amount of actomyosin indicated. The myosin component appearing at the low temperature was separated in the preparative ultracentrifuge and identified as myosin. As can be seen from the diagram, an intermediate situation exists at 16·0° C. The behaviour of the actomyosin was the same whether the two proteins were mixed at room temperature or in an ice bath. Thus it seems that the formation of actomyosin is a strongly endothermic equilibrium reaction. The viscosimetric experiments of Csapó[9] also indicate that the amount of actomyosin formed depends on temperature. The effect of adenosine triphosphate on this equilibrium



Sedimentation diagrams of actomyosin at various temperatures. Speed 59,780 r.p.m. *M*, myosin boundary; *AM*, actomyosin boundary. (1) Temperature 4·9° C. Time after reaching speed, 16 min. (2) Temperature 16·0° C. Time after reaching speed, 16 min. (3) Temperature 26·5° C. Time after reaching speed, 8 min. Diagram (3) made with higher bar magnification than (1) and (2)

reaction is similar to raising the ionic strength or lowering the temperature, that is, a disruption of the actomyosin complex occurs.

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Action of Insulin on Thiamine Phosphorylation

Previously we have observed that the respiratory quotient of animals, in which alloxan diabetes reaches a certain severity, is not appreciably affected by administration of thiamine + glucose[1]. Also, under the same experimental conditions, the administration of thiamine was not followed by a marked increase of liver cocarboxylase, whereas in normal animals or in those affected by less severe forms of the disease, such an increase does occur[2]. Therefore it was concluded that in alloxan diabetes a disturbance of the thiamine phosphorylation processes may occur.

In order to investigate whether insulin acts on the formation of cocarboxylase from thiamine or not, we have studied its action on those forms of alloxan diabetes in which the phosphorylation of thiamine is nearly completely inhibited. To such an end we have worked with diabetic rats, severely affected, in which the respiratory quotient was not increased after 1–1½ hr. from the time of glucose + thiamine administration.

In a typical experiment the liver cocarboxylase content of a diabetic rat treated with insulin (20 I.U./kgm.) + thiamine (15 mgm./kgm.) was determined and compared with the liver cocarboxylase content of diabetic rats which had been treated with thiamine alone (15 mgm./kgm.). In all experiments the animals were killed 40 minutes after the corresponding treatment. Cocarboxylase was determined by the method of Ochoa and Peters[3] with minor adaptations[4].

Cocarboxylase Content of Liver of Alloxan Diabetic Rats, Untreated and After Treatment with Thiamine (15 mgm./kgm.), with Insulin (20 I.U./kgm.) and with Thiamine (15 mgm./kgm.) + Insulin (20 I.U./kgm.)

Rats	No. of animals treated	Liver cocarboxylase (μgm./gm. wet tissue)	
		Range	Average
Diabetic	15	3·64–5·20	4·35 ± 0·16
Diabetic + thiamine	15	4·12–6·03	5·04 ± 0·19
Diabetic + insulin	15	3·93–6·17	4·73 ± 0·21
Diabetic + thiamine + insulin	15	6·40–9·49	7·68 ± 0·26

It will be seen from the accompanying table that liver cocarboxylase content is increased in diabetic animals treated with thiamine + insulin, in contrast to those treated with thiamine alone. On the other hand, administration of insulin (20 I.U./kgm.) to diabetic rats not treated with thiamine does not give rise to a significant increase in the cocarboxylase content when compared with the untreated rats. The negative results obtained with insulin alone may be attributed to a low content of the thiamine in diabetic animals[5], probably due to a low absorption of thiamine through the intestine[1]. Hence we may conclude that insulin enhances the thiamine phosphorylation in the diabetic animal when the latter has a sufficient amount of thiamine.

A full report of this work will appear elsewhere.

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Separation of Coombs Reagent into Two Fractions

It was shown by Dacie[1] that normal human sera contain what appears to be an incomplete antibody which becomes attached to erythrocytes at 4° C. and which can be demonstrated by the antiglobulin technique of Coombs. It appears, however, that the substance in the Coombs reagent (rabbit anti-human globulin serum) involved in the reaction is distinct from that involved in the agglutination by Coombs reagent of red cells sensitized by incomplete *Rh* antibodies, since the Coombs reagent can be separated into two fractions by absorption with suitably sensitized cells.

Fraction 1, made by absorbing twice with an equal volume of cells sensitized by Dacie's cold incomplete antibody, agglutinates *Rh*-sensitized cells almost as well as the unabsorbed Coombs reagent while failing to agglutinate cells sensitized by Dacie's antibody.

Fraction 2, made by absorbing three times with an equal volume of *Rh*-sensitized cells, agglutinates to an almost undiminished titre cells sensitized by Dacie's antibody, but gives no reaction with *Rh*-sensitized cells (see Table 1).

Table 1. Absorption of Coombs Reagent with Sensitized Cells

Absorbing cells	Titre: Test cells: *Da*	*Rh*
Nil	16	32
Da	Nil	16
Rh	8	Nil

Da, cells sensitized by Dacie's cold incomplete antibody.
Rh, cells sensitized by incomplete *Rh*-antibody.

That the reaction is of a similar nature to that described by Coombs is shown by the fact that normal rabbit serum does not agglutinate cells sensitized by Dacie's antibody; it is also shown by the inhibition of the reaction by human serum or human gamma-globulin (see Table 2). The titres shown in Table 2 would appear to indicate that two different fractions of human serum are responsible for inhibiting the two reactions, and that the purification of the gamma-

globulin has effected an approximately eighty-fold reduction in one fraction as compared with the other. Coombs reagent prepared using purified gamma-globulin as antigen, however, had similar titres, with cells sensitized by anti-*Rh* and by Dacie's antibody, to those obtained with Coombs reagent prepared using whole serum as antigen, suggesting that the purification of the gamma-globulin was incomplete.

Table 2. Greatest Dilution of Whole Human Serum and Gamma-Globulin Completely Inhibiting Agglutination of Sensitized Cells by an Equal Volume of Coombs Reagent

Inhibitor	Test cells : *Da*	*Rh*
Whole serum	1 : 20	1 : 1,000
Gamma-globulin (8·3 per cent)	Undiluted	1 : 4,000

The separation of the two fractions by absorption as described above is rather a troublesome procedure, and a far more convenient and satisfactory method of preparing fraction 2 is simply to add to some Coombs reagent a suitable concentration of gamma-globulin. When Coombs reagent is absorbed with an equal volume of group *A* cells which have been agglutinated by the isoagglutinin anti-*A* and thoroughly washed, fraction 2 is removed from the reagent and fraction 1 retains its activity unimpaired (see Table 3). This is a more convenient means of preparing fraction 1 than that described above, since the reagents are readily available, and the cells can be more readily coated with a high concentration of antibody than is the case when using Dacie's antibody.

Table 3. Absorption of Coombs Reagent with Group *A* Cells Coated with Anti-*A*

	Titre	
	Test cells : *Da*	*Rh*
Before absorption	4	16
After absorption	Nil	16

The observation that cells coated with anti-*A* react with fraction 2 only suggests that the isoagglutinins are of a different nature from incomplete *Rh*-antibodies and are akin to Dacie's antibody.

It is interesting to examine various antibodies using the two fractions of Coombs reagent. Ten samples of incomplete anti-*Rh* reacted only with fraction 1, as expected, as did two samples of incomplete anti-Kell and one incomplete anti-Fy^a. The incomplete antibodies in three anti-*A* sera of immune type also only reacted with fraction 1. These sera came from patients of group *O* who had received group *A* blood (two cases), or had infants affected with hæmolytic disease due to anti-*A* (one case), and the anti-*A* agglutinins (which react with fraction 2—*vide supra*) were removed by the addition of group *A* saliva before sensitizing group *A* cells with the sera as described by Witebsky[2].

Sera of this type should be avoided when preparing fraction 1 by the use of anti-*A*. They sometimes occur in apparently normal individuals[3].

My thanks are due to Dr. F. Stratton for preparing the Coombs reagent using purified gamma-globulin as antigen.

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Improved Spray Reagent for the Detection of Sugars

Search has been going on for a universal spraying reagent for the detection of sugars ever since partition chromatography was employed for the separation and identification of sugars by Partridge[1–5].

We have found that *p*-anisidine phosphate in ethanol is yet another spray reagent which can be used for detecting a variety of sugars. With this reagent aldopentoses give a dark brown colour, fructose a lemon-yellow colour, rhamnose a pinkish-brown colour, aldohexoses a light brown colour, lactose a dull yellow colour, sucrose a brownish-yellow colour, maltose a very faint brownish-yellow colour (which becomes light brown on prolonged heating), raffinose a yellowish-brown colour, and glucuronic acid a pink colour. Polyhydroxy alcohols like sorbitol and mannitol do not give any colour. The intensity and the definition of spots are enhanced in ultra-violet light. The background of the sprayed paper remains unaffected. The effect of this reagent on the methylated sugars could not be studied because they were not available to us.

The *p*-anisidine phosphate reagent is prepared by dissolving *p*-anisidine (0·5 gm.) in phosphoric acid (2 c.c., 1·75 sp. gr.) and diluting the solution with ethanol to 50 ml. The precipitated *p*-anisidine phosphate is filtered and the filtrate used as the spray reagent. The undissolved *p*-anisidine phosphate is dissolved in the minimum quantity of water, diluted with an equal volume of ethanol, and to this solution is then added phosphoric acid (1·75 sp. gr.) to the extent of 2 per cent (by volume). The two solutions can be mixed together or can be used separately. Spots of 1 per cent solutions of the sugars are put on a Whatman No. 1 paper strip, dried, sprayed with the reagent and then heated in an oven at 95°–100°. The colours appear within three to five minutes. Pentoses are the first to show a colour, then the fructose and those sugars containing fructose. It is interesting to note that the disaccharides and trisaccharides which have fructose as one of their component sugars give a prominent yellowish tinge in the spot. Mixtures of sugars after being separated on the paper chromatogram and sprayed with the reagent give the characteristic colorations. There is, however, a gradual fading of colours with time, but the colours remain distinctive for about a week.

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Maintenance of Grafted Rabbit Luteal Tissue

By administration of œstrogen the corpora lutea of the rabbit can be maintained after hypophysectomy, and prolonged beyond the normal term of pseudopregnancy; and these corpora can be presumed to be functional[1,2]. Recently[3], it has been shown that the maintenance is a direct effect of œstrogen on the luteal tissue. Implantation of, for

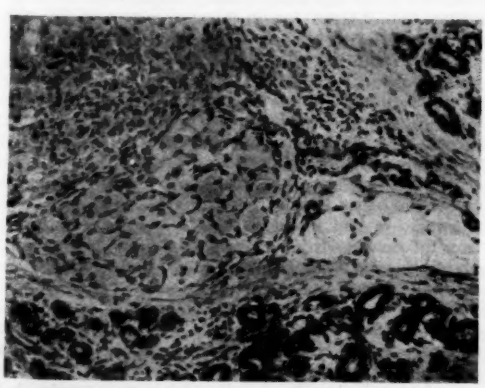
example, stilbœstrol dipalmitate or dibutyrate directly into a corpus will cause maintenance of adjacent luteal cells when in other corpora they have degenerated following hypophysectomy, parturition, or the end of the normal period of pseudopregnancy. However (though it is probable enough), it is not certain that luteal function, as well as structure, is directly maintained by œstrogen.

Luteal tissue grafted into mammary gland may be maintained by stilbœstrol. In the following experiments, corpora (or parts thereof) were placed in pockets torn between skin and skin muscle; no sutures were used to hold the grafts in place. The grafts included thecal tissue; no recognizable interstitial cells survived. Subcutaneous implants of stilbœstrol were made two to four days before the tissue was grafted. The rate of absorption from these implants would have been adequate to maintain corpora in the ovary.

In three animals these œstrogen implants were not removed; rabbits Nos. 1 and 2 were killed seven days, and No. 3 fourteen days, after grafting luteal tissue. Both ovaries of No. 1 were removed at the time of grafting, five days after ovulation. No. 2 was grafted at the same time, also with luteal tissue from No 1. The ovaries of rabbit No. 2 were not removed; unfortunately, ovulation occurred, presumably as a result of excitement just before operation. Rabbit No. 3 had not ovulated, and its ovaries were removed when the graft was made. The tissue used came from No. 5 (listed below) seven days after ovulation. In each of these animals some part of the graft survived, though the greater amount—particularly the central portions—did not. Mammary tissue was growing into the graft of No. 3.

In two other rabbits œstrogen, which when implanted in the ovary would have only a localized maintenance effect, was placed with the graft; and the stilbœstrol tablet giving an œstrogen concentration effective systemically was removed some days before the graft was examined.

Rabbit No. 4 did not ovulate, and its ovaries were not removed. A corpus luteum in another rabbit was implanted with stilbœstrol di-*n*-butyrate. Some days later this whole corpus, now nine days old, was grafted into rabbit No. 4. The subcutaneous stilbœstrol was removed three days later, and the graft examined a fortnight after this. Some luteal cells at the edge of the graft appeared to have survived for a time; however, all were degenerate at the time of killing.



Rabbit No. 5, surviving luteal cells in mammary graft. × 110

Rabbit No. 5 was operated on seven days after ovulation, only one ovary removed, and part of a corpus from it, together with a flake of stilbœstrol dipalmitate, placed in a mamma. The graft was examined fourteen days later, a week after the main source of supplementary œstrogen was withdrawn. Whereas luteal cells in the remaining ovary were degenerating, cells of the graft (illustrated here) were maintained.

The response of the mammary tissue is not considered adequately to demonstrate progesterone secretion by the grafts. However, the experiments are reported, since they serve to confirm that the maintenance effect of œstrogen is a direct action, and, further, show the independence of the corpus luteum (provided it is supplied with œstrogen) of other ovarian tissue.

I am grateful to Mr. D. Canwell for the preparation of many sections.

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An Uncommon Type of Bacteriophage

IT has been the general experience of phage investigators[1] that bacterial viruses reach their highest titres when preying on rapidly growing cultures, differing thereby from the large group of plant and animal viruses, which are able to multiply in host cells regardless of stage of development. Krueger *et al.*[2] showed that staphylococci will support phage reproduction in the presence of penicillin which inhibits their own growth; but such organisms must first be 'activated', which means they must have entered the logarithmic phase of growth.

Recently, we have encountered a coliphage, originally isolated from sewage, which is characterized by a preference for old (20-hr.) rather than young (4-hr.) cells of its host for optimal development. It was observed that the addition of phage to the former induces rapid lysis not preceded by resumption of growth, whereas the latter appeared more resistant to the destructive effect of the virus unless the infective dose was very large.

In order to obtain a quantitative estimation of the action of the phage on its host, 10^8 phage particles, suspended in 0·1 ml. of Locke's solution, were mixed with bacteria in three different phases of growth; the volume was made up to 1·0 ml. with nutrient broth. Incubation was carried out for 120 min. at 37°. At this time lysis of 4-hr. and 20-hr. old cells was always complete, whereas 44-hr. old cells were only partially lysed. Aliquots were removed, suitably diluted, and the phage titres determined by the method of Gratia[3]. The ribose contents of 5 per cent trichloracetic acid extracts of the bacteria was estimated in accordance with the procedure outlined by Kerr and Seraidarian[4]. The results are presented in the accompanying table.

The role of ribonucleoprotein in phage multiplication has been a subject of controversy. Price[5]

Age of culture (hr.)	No. of organisms	Ribose contents (μgm.)	Final No. of phage plaques per ml. (× 10^9)
4	2×10^8	4·6	37·8
4	3×10^8	6·9	21·8
20	3×10^8	2·2	77·0
44	3×10^8	0·9	2·6

reported an increase in yield of phage from *Staphylococcus muscæ* cells treated with a ribonucleoprotein fraction from yeast. On the other hand, Cohen[6] has shown that ribose is produced by the *B* strain of *Escherichia coli* from glucose and gluconate through an oxidative pathway not conducive to the synthesis of virus deoxyribonucleoprotein. On the basis of our results, it may be argued that one prerequisite for maximal phage production is a definite concentration of ribonucleoprotein. This concentration might be expected to vary considerably with the type of phage.

It may be of interest to know whether the coliphage here described constitutes a rare deviation from the norm, or whether the bacterial viruses studied in much detail in the past just chanced to belong to a common type. The ability of this phage to multiply in cells which are in a natural resting state should facilitate the evaluation of antiviral agents.

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Nov. 23.

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An Examination of *Bacterium thiocyanoxidans*

In 1937 Happold and Key[1] isolated from sewage effluent treated with gas-works liquor an organism which was capable of multiplication in solutions containing only potassium or ammonium thiocyanate and phosphate. Ammonium sulphate and carbon dioxide were produced. The organism grew to form small dewdrop colonies on agar containing only thiocyanate, but it also formed large yellowish-green colonies on the surface of ordinary 'nutrient agar'. After growth on the latter medium, the organism failed to utilize thiocyanate when transferred to inorganic solutions, irrespective of the presence or absence of thiocyanate in the nutrient agar. Some time later[2] the isolation was made again, and the organism obtained showed all the same properties, including loss of the ability to utilize thiocyanate after growth to form yellowish-green pigmented colonies on media containing organic nutrients. During both isolation procedures, serial platings of the organism had been undertaken with successive selection of single colonies. The morphology of the organism and of the colonies formed on inorganic salt – agar medium appeared to be similar, although on the second occasion there was some evidence of the appearance of more than one type of colony on nutrient agar.

In view of the inability to utilize thiocyanate after growth on nutrient agar and of the suggestion of multiple colony formation when growing on the surface of this medium, it was decided to attempt to grow a culture from a single-cell isolation using the agar-block technique and dark-ground illumination[3,4]. Three types of organism were isolated. One grew in a simple solution of 0·01 *M* potassium thiocyanate and 0·01 *M* phosphate buffer at *p*H 6·9, utilizing the thiocyanate. The growth of this organism was strongly inhibited by the presence of organic nutrients in the medium. The two other types of organism grew slowly in ammonium thiocyanate medium, but appeared to use little or no thiocyanate. They grew well on the surface of nutrient agar and one produced a greenish-yellow pigment.

It must therefore be presumed that the culture originally called *Bacterium thiocyanoxidans* was, in fact, a mixture of organisms, growing in some form of symbiosis in solutions of thiocyanate not containing organic nutrients. Subcultured on media containing organic substances such as nutrient agar, the contaminating organisms are able to overgrow the thiocyanate utilizer, which apparently cannot multiply under these conditions.

Unfortunately, whereas in the original mixed culture the thiocyanate-utilizing organism appears to be very hardy and remains viable for many weeks in solutions of thiocyanate or on thiocyanate agar, in pure culture it is very delicate.

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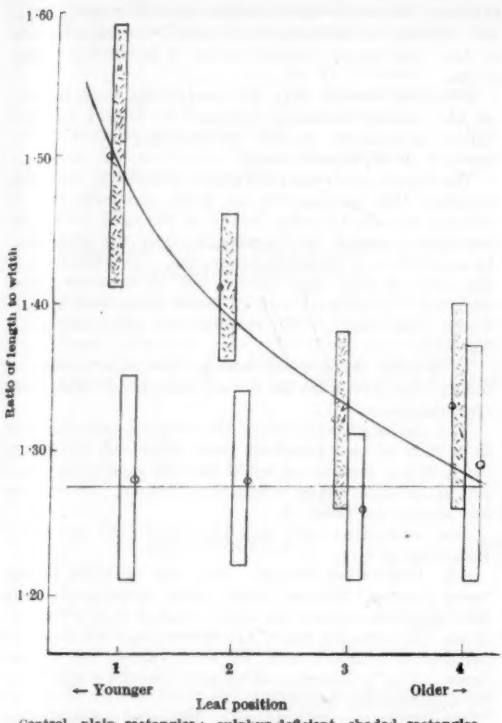
Influence of Sulphur Nutrition on Leaf Morphology

In connexion with certain experiments dealing with the influence of sulphur nutrition on tobacco mosaic virus, the number of local lesions per unit leaf area was used as the criterion of susceptibility to the virus. The procedure involved the rubbing of a suspension of the virus on selected leaves of *Nicotiana glutinosa*, the test plant.

Sadasivan[1], working with plants adequately supplied with all essential elements, found that the product (length × width at widest point × a constant factor 0·88) compared favourably with more direct procedures as a measure of leaf area in *Nicotiana glutinosa*. The use of this formula is only valid, of course, where the particular experimental treatment does not lead to significant differences in the ratio of leaf length to width. Cursory examination of leaves from sulphur-deficient and control plants in the present work indicated that this requirement was not satisfied.

The methods employed for the culture of *Nicotiana glutinosa* were essentially those described for Turkish tobacco in an earlier communication[2]. Uniform three- to four-leaf seedlings were transplanted to complete solution from soil. After two weeks, half



Control, plain rectangles; sulphur-deficient, shaded rectangles. ⊙ denotes mean

Effect of age of leaf and sulphur nutrition on the length–width ratio

the plants were supplied with fresh complete solution, and half transferred to crocks containing sulphur-deficient solution. The latter differed from complete solution only in the replacement of magnesium sulphate by an equivalent amount of the chloride. Treatments were randomized on the greenhouse bench. In three weeks, when symptoms of sulphur-deficiency were pronounced, the lengths and widths of four middle leaves on each plant were measured with a centimetre rule, and the ratio of length to width was determined for every leaf. The results are summarized in the accompanying graph, in which an amount equal to the standard error has been both added to and subtracted from each mean value.

Whereas there is no significant difference in the length–width ratio of the various lots of leaves from the control plants, there is a steady increase in this ratio as more and more juvenile sulphur-deficient leaves are compared. Sulphur is relatively immobile in deficiency. The degree of deficiency, and the extent of chlorosis induced by the deficiency, are affected similarly to the length–width ratio by leaf age in sulphur-deficient plants[3]. These results suggest, therefore, a close correlation between sulphur nutrition and leaf morphology.

Not only is this work of interest from the point of view of the physiology of leaf differentiation, but also it emphasizes the need for modification of Sadasivan's leaf-area formula for plants subjected to different experimental conditions. The use of such modified formulæ in virus susceptibility determinations will be described in a forthcoming publication.

This investigation was supported by a grant from the Microbiological Institute, U.S. Public Health Service.

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Oct. 4.

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Alkaloid Biogenesis in *Datura*

Mydriatic alkaloids accumulate in tomato scions grown on root-stocks of *Datura* and *Atropa* but are not detectable in scions grown on reciprocal grafts[1–7]; they have been found in sap exuding from excised *Datura* stems[7], in culture fluids of excised *Datura* roots[7] and in tobacco leaves grafted on to *Datura* and *Atropa* stocks[2,6,7]. One interpretation of this evidence is that the site of synthesis of the mydriatic alkaloids of *Datura* and *Atropa* is the root.

Certain facts, however, cannot be interpreted in the same way. For example: the production of alkaloids responding to the Vitali–Morin reaction in cultured detached leaves of *Atropa*[8]; the histochemical reactions of the apical meristems of the root and stem of germinating seedlings of *Atropa* and *Datura*[9]; the occurrence of mydriatic alkaloids in all parts of a graft of *Datura* on tomato[10]; and their presence in insufficient quantity in the sap bleeding from excised *Datura* roots to account for their proportion in the tops[10].

Reliable information on the site of alkaloidal biogenesis is not necessarily obtainable from experiments with grafts involving a pair of generically different plants, especially when only one member of the graft produces alkaloids; the metabolism of two such plants differs at least in one important respect, namely, alkaloidal metabolism.

We have prepared grafts of seedlings of *Datura ferox* and *Datura tatula* var. *inermis*, both of which produce in the mature plants alkaloids principally of the tropane group, the former hyoscine and meteloidine[11,12], and the latter hyoscine and hyoscyamine. The two types of graft flourished well but matured at different times; accordingly the flowering tops of control plants were collected at the same time as the tops of the corresponding grafts. The alkaloids in the dried material were determined by the partition chromatographic method we have described previously[11], and characterized by their position on the elution curve from the column and by the melting point of the aurichloride or picrate and mixed melting point with the appropriate authentic compound.

Alkaloids in *Datura* Grafts

Sample	Hyoscine (per cent)	Hyoscyamine (per cent)	Meteloidine (per cent)	Other bases as hyoscyamine (per cent)
Datura tatula var. *inermis* (control)	0·12	0·24	—	0·01
D. tatula scion grown on *D. ferox* stock	0·07	0·11	—	0·05
D. ferox (control)	0·31	—	0·10	0·11
D. ferox scion grown on *D. tatula* stock	0·39	—	0·05	0·04

Although the shape of the elution curves afforded no evidence of meteloidine in *D. tatula* scions grown on *D. ferox* stock, nor of hyoscyamine in a *D. ferox* scion grown on a *D. tatula* stock, the complete absence of these alkaloids has not been proved.

From the results recorded in the table, it appears that the process of grafting has no great influence on the overall production of alkaloids and that the root of *D. ferox* and of *D. tatula* var. *inermis* is not the only site of biogenesis of the whole alkaloidal molecule. Indeed, it may be concluded that at least the final stages of biogenesis take place in the aerial parts of these plants.

It is not unreasonable to suppose that a full interpretation of the evidence on the site of the biosynthesis of tropane alkaloids should consider the possibility of the transformation of one alkaloid into another and their translocation as structural fragments; the reversible interconversion of the heterocyclic fragments of hyoscine, hyoscyamine and meteloidine does not appear biochemically improbable.

A full account of this and further work on these grafts will be published elsewhere.

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Oct. 2.

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Control of the Mealybug Vectors of the Swollen Shoot Virus by a Systemic Insecticide

Detailed field and laboratory experiments have been carried out to determine the effect of different systemic insecticides when applied to cacao trees by spraying, tree injection and soil treatment on the mealybugs *Pseudococcus njalensis*, Laing, and *Pseudococcus citri*, Risso., the main vectors of the swollen shoot virus of cacao. They have shown that *CR*409, a systemic insecticide containing as main ingredient bisdimethylamino-fluoro-phosphine oxide, gave the best results when applied to the soil directly around the trunk of the trees in a shallow trench at a dosage based on a girth-weight correlation which has been used in all experiments described below. Five hundred trees naturally infested with mealybugs were treated; 10 per cent of the trees, chosen at random, were cut down before and after treatment, the number of all stages of mealybugs on all parts of the tree being counted under a binocular microscope.

After six weeks, only 35 mealybugs were present on the treated trees as opposed to 42,971 counted before treatment on the untreated portion (a reduction of 99·9 per cent).

The experiment was continued in order to establish whether the trees could be kept virtually free of vectors for six months, which is thought to be the maximum period of latent infection by the virus, by a number of further treatments. Re-treatment at the same dosage was carried out on separate plots, each of a hundred trees, at eight-week and twelve-week intervals. The results are summarized in Table 1.

It is clear from these results that the number of mealybugs was kept at a very low level with three treatments.

The material build-up of the vectors was observed in a plot of two hundred trees after one treatment only, 10 per cent being felled and the mealybug population on them being counted as before. The results are shown in Table 2.

Soil treatment with this insecticide did not prove detrimental to:

(*a*) *Pollinating insects.* Any set or open flowers were rogued thirteen days after treatment, from 500 labelled clusters on both treated and untreated trees. A fortnight later, 117 flowers had set from the untreated clusters and 90 from those on treated trees. The pollination does not therefore appear to be significantly affected.

(*b*) *Parasites and predators.* This was demonstrated by recording the number in the 500-tree experiment mentioned initially. The number of parasites and predators found on trees examined before treatment was: Coccinellidæ, 107; Cecidomyidæ, 3. Six weeks after treatment the Coccinellidæ were reduced to three, as they had presumably insufficient mealybugs to sustain them. This also accounts for the disappearance of the Cecidomyidæ. Forty-two arachnids (*Withius subruber*, Simon, which is also a mealybug predator) appeared.

This work was carried out by the Pest Control, Ltd., team at the West African Cacao Research Institute, Tafo, Gold Coast, and we are obliged to the Director of the West African Cacao Research Institute and the Directors of Pest Control, Ltd., for permission to publish this communication, and also

Table 1. Number of Mealybugs after Various Treatments

Treatment	Pre-treatment count	After 8 weeks (1 treatment)	Reduct. (%)	After 16 weeks (2 treatments)	Reduct. (%)	After 24 weeks (3 treatments)	Reduct. (%)
Every 8 weeks	6,966	62	99·1	84	98·8	45	99·4
		After 12 weeks (1 treatment)		After 24 weeks (2 treatments)			
Every 12 weeks	13,496	306	97·7	765	94·3		

Table 2. Number of Mealybugs at Increasing Times after One Treatment
(Number of mealybugs per 10 per cent of trees before the first treatment, 15,408)

After 6 weeks	Reduct. (%)	After 12 weeks	Reduct. (%)	After 18 weeks	Reduct. (%)	After 24 weeks	Reduct. (%)
16	99·9	388	97·5	1,439	90·6	1,637	84·5

to the Senior Entomologist, Chemist and Agronomist of the West African Cacao Research Institute for help.

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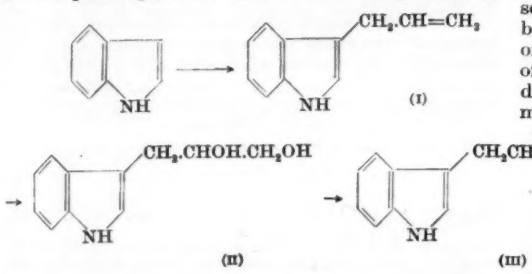
Tafo. Aug. 30.

Synthesis and Biological Activity of β-Indolylacetaldehyde

β-Indolylacetaldehyde (III), the aldehyde corresponding to heteroauxin, has been reported to have been detected (for example, by enzymatic oxidation to an active acidic auxin) in the tissues of several plant species[1,2]. It has also been postulated



as an intermediate in the possible *in vivo* conversion of tryptophane into heteroauxin. Larsen[1] has described the preparation of a material containing about two per cent of β-indolylacetaldehyde by heating tryptophane with ninhydrin (or isatin) in aqueous solution; but so far, the pure compound has not been isolated or characterized by means of crystalline derivatives.

The desirability of having the pure aldehyde available for biological and chemical examination led us to embark upon the accompanying synthetical approach.

β-Allylindole (I) (picrate, m.p. 105·5–106°) was prepared from indolylmagnesium bromide and allyl bromide. Analogy with other reactions of indolyl Grignard reagents would indicate that the allyl group is attached at the β-position, and this was confirmed by infra-red measurements (to be reported separately). β-Allylindole reacted readily with osmium tetroxide to furnish the glycol (II), melting point 97·5–98°. This on cleavage with sodium periodate gave β-indolylacetaldehyde (III), boiling point 120° (bath temp., short-path still) at 10^{-5} mm., n_D^{18} 1·6178 (found: C, 75·15; H, 5·3. $C_{10}H_9ON$ requires C, 75·4; H, 5·7 per cent). Light absorption in ethanol, maxima at 2170 A., 2800 A. and 2890 A. (ε = 32,600, 6,020 and 4,980 respectively). Infra-red spectrum: N—H stretching frequency at 3,430 cm.$^{-1}$, and C = O stretching frequency at 1,705 cm.$^{-1}$. The aldehyde was further characterized as the semicarbazone (melting point 142–155°), 2 : 4-dinitrophenylhydrazone (melting point 196–202°), and the dimedone derivative (melting point 148–152°), the three derivatives giving correct analytical data (melting points were determined on a Kofler block).

From previously reported work employing crude β-indolylacetaldehyde, it is uncertain whether this compound functions as a plant growth-hormone. The pure aldehyde has now been tested for biological activity in the *Avena* straight-growth test[3] in the Department of Botany of this University. We are indebted to Dr. J. A. Bentley and Mr. S. Housley for the following preliminary report on its activity.

(*a*) A 1 mgm./l. solution of the aldehyde shows an activity equivalent to that of a 0·1 mgm./l. solution of β-indolylacetic acid. With a 10 mgm./l. solution, the activity is still only equivalent to that of a 0·1–0·2 mgm./l. solution of heteroauxin.

(*b*) During the biological assay, an acidic substance (probably β-indolylacetic acid) is produced. For example, using a 1 mgm./l. solution of the aldehyde, the concentration of the acidic product determined by subsequent bio-assay is equivalent to a 0·1–0·2 mgm./l. solution of heteroauxin.

(*c*) However, with control solutions of the aldehyde exposed to the same conditions as the test solutions but without the presence of coleoptile sections, an acidic substance is produced which by bio-assay is equivalent to a solution of heteroauxin of approximately only 1 per cent of the concentration of the aldehyde in the solution. Thus, *in vitro* change does not account for all the production of acidic material in the presence of coleoptiles.

Since the activity of the acidic substance produced in the presence of coleoptiles is equal to, or greater than, the activity of a solution of β-indolylacetaldehyde at the same concentration, it is concluded that the aldehyde itself is either inactive or inhibitory.

Further details of the synthetical work will be published elsewhere; a more detailed account of the biological results will be published separately in the botanical literature.

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A New Colour Reaction of Streptomycin

The reaction between streptomycin and diacetyl seems not to have been reported in the literature. When mixed with diacetyl in aqueous alkaline solution, this antibiotic produces a pink colour by virtue of its guanidine groupings, the reaction being of the type first described by Voges and Proskauer[1], and investigated by several other workers[2].

Like the original Voges–Proskauer reaction, the colour production with streptomycin could be greatly intensified by the further addition of α-naphthol, following the procedure of Barritt[3]. Such a modification increased the sensitivity only; other properties of the two reactions were essentially the same, namely: (1) colour was slow to develop, and faded after reaching a maximum density; (2) oxygen was necessary both for colour development and for the fading process, since sodium sulphite or ascorbic acid could be used to halt the reaction at any desired stage; (3) strong absorption was found at the shortest wave-lengths of visible light, with a characteristic

band in the green region (peaks at 504 millimicrons for the first reaction and at 515 for the modification); the absorption curve was similar to that given by streptomycin in the Sakaguchi reaction.

The sensitivity of the modification was limited to about 50 micrograms of free base in a total of 15 ml. Specificity was of a low order since many guanidine derivatives interfered. The reaction is therefore not recommended in its present form for clinical determinations, since better ones are available, for example, that of Boxer and Jelinek[4]. It should prove suitable, however, for the chemical assay of relatively pure preparations, and for the detection of streptomycin on chromatograms.

Dihydrostreptomycin resembled the natural antibiotic in this reaction.

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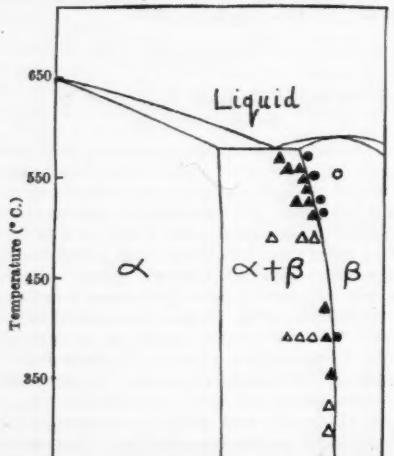
Solubility of Magnesium in Lithium

In view of the possible commercial application of alloys of magnesium and lithium, the equilibrium diagram of these two metals has assumed practical as well as theoretical importance. The diagram is, in general, well established except for the solid solubility of magnesium in lithium.

This boundary has been reported by Henry and Cordiano[1] as 29·3 atomic per cent lithium at room temperature and 27·8 atomic per cent at the eutectic. The corresponding figures of Saldau and Schamray[2] were 30·5 per cent and 29·0 per cent, respectively. Grube, von Zeppelin and Bumm[3] represented tentatively a vertical boundary at 28·6 per cent lithium. Some evidence of an increase in the solubility with temperature was shown by Hume-Rothery, Raynor and Butchers[4], although no values were given.



Single-phase alloys: ○, not analysed; ●, analysed.
Two-phase alloys: △, „ „; ▲, „

I have now been able to fix this boundary from microscopical examination of alloys annealed and quenched from various temperatures, interpolation from a smooth curve giving the solid solubility limits as follows:

350° C.	28·3 atomic per cent lithium
450 „	27·8 „ „ „ „
550 „	26·7 „ „ „ „
575 „	25·3 „ „ „ „
588 „	24·1 „ „ „ „

Additional evidence for an increase in solubility (see diagram) was obtained by solution treating and quenching from 425° C. an alloy containing 28·3 per cent lithium. This alloy aged from 28 to 48 (Vickers pyramid numeral) during three weeks at room temperature. It was found impossible to retain the alpha phase in solution on quenching from the higher temperatures with lower lithium content; consequently alloys with about 26 per cent lithium failed to age-harden.

The alpha phase represents the close-packed-hexagonal structure of magnesium, and the beta phase the body-centred-cubic structure of lithium.

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Oct. 9.

[1] Henry, O. H., and Cordiano, H. V., *Trans. Amer. Inst. Min. Met. Eng.*, **111**, 319 (1934).
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Negative Electric Fields in the Atmosphere

Negative electric fields have been observed at Durham by Chalmers and Little[1] in mist, and by Chalmers and Hutchinson[2] in the presence of low stratus cloud. These results appeared to indicate a separation of charge in the atmosphere under conditions when precipitation played no part.

Investigation of the phenomena with transportable apparatus has shown that the effect is due to negative ions produced by discharges at pylons of overhead high-tension power lines and travelling in the wind; the effect is sometimes still noticeable at some miles from the source of the ions, particularly when the humidity is high. Calculations show that the effects observed can be accounted for by a current of negative ions of the order of 1 μamp. per pylon.

Since these negative fields are produced by a 'man-made' source, the conclusions quoted above in regard to separation of charge are no longer valid. A further consequence of the present observation is that care must be taken to allow for any possible similar effects before it can be legitimate to interpret observations of electric field in terms of charge production in clouds.

The effect is being investigated further, and detailed results will be published elsewhere.

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Oct. 8.

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FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Monday, February 25

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. L. D. Derry, Dr. E. B. Evans, Mr. B. A. Faulkner and Mr. E. C. G. Jelfs: "Air and Vapour Release from Aviation Fuels".

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. M. Venner: "The Electron Microscope".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr. Arthur Bolton: "A New Approach to the Elastic Analysis of Two-Dimensional Rigid Frames".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. P. D. Baird: "The Baffin Island Expedition".

Tuesday, February 26

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Helen Spurway: "Cybernetics and Animal Communication".•

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. H. Heywood: "Dusts and Powders in Nature and Industry". (Further Lectures on March 4 and 11.)

UNIVERSITY OF LONDON (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. M. Cosyns: "Caving in the Pyrenees".•

UNIVERSITY OF LONDON (in the Department of Civil and Mechanical Engineering, King's College, Strand, London, W.C.2), at 5.30 p.m.—Mr. O. J. Masterman: "Pre-stressed Concrete".• (Further Lecture on March 4).

MANCHESTER GEOGRAPHICAL SOCIETY (in the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Mr. R. Kay Gresswell: "The Story of the South Lancashire Coastline".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. W. Fishwick: "Temperature Pocket Lags".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. D. J. Kingsbury and Mr. D. B. Johnston: "An Introduction to High-Voltage Air Blast Circuit Breakers".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—"Sailplanes and Meteorology" (Mr. L. Welch: "Meteorology from the Pilot's Point of View"; Dr. R. S. Scorer: "Gravity as an Aid to Soaring").

Wednesday, February 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Rt. Hon. the Earl of Halsbury: "The Work of the National Research Development Corporation".

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. J. S. Hizzey and Mr. J. R. Turner: "Television Interference".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. A. W. Peterson: "The Statistics of Gambling".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. T. G. Halsall: "Some Recent Developments in Chemotherapeutics".

INSTITUTE OF PETROLEUM, STANLOW BRANCH (joint meeting with the LIVERPOOL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at the Grosvenor Hotel, Chester), at 7.30 p.m.—Prof. E. R. H. Jones, F.R.S.: "Acetylene Chemistry".

Thursday, February 28

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. E. Bradbury and Mr. C. Martin: "The Effect of the Temperature of Preparation on the Mechanical Properties and Structure of Gelatine Films"; Mr. D. K. Ashpole: "The Moisture Relations of Textile Fibres at High Humidities".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Main Lecture Theatre, National Hospital, Queen Square, London, W.C.1), at 5.15 p.m.—Dr. C. M. Harris: "Building Blocks of Speech".

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. W. B. Emery: "Saqqara and the Dynastic Race".•

CHEMICAL SOCIETY, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Manchester), at 6.30 p.m.—Prof. T. Reichstein (Basle): "The Chemistry of the Cardiac Glycosides" (Centenary Lecture).

Friday, February 29

ROYAL INSTITUTE OF PHILOSOPHY (at University Hall, 14 Gordon Square, London, W.C.1), at 5.15 p.m.—Prof. G. C. Field: "The Freedom of the Will".•

ROYAL METEOROLOGICAL SOCIETY, SCOTTISH CENTRE (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 5.15 p.m.—Annual General Meeting; Discussion on "Tropical Meteorology".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. F. Danielli: "Cell Physiology and Pharmacology, 1, Some Cytochemical and Cytological Aspects of Drug Action".•

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Henry Cohen: "The Brain as a Machine".

Saturday, March 1

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Prof. Max Gluckman: "The Masked Dancers of Barotseland in Northern Rhodesia".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH BIOCHEMIST (graduate in either science or medicine with experience in modern techniques of protein chemistry) to investigate physical and chemical changes in body proteins in disease—The Secretary, Courtauld Institute of Biochemistry, Middlesex Hospital Medical School, London, W.1 (February 29).

ASSISTANT IN THE DEPARTMENT OF SOCIAL ANTHROPOLOGY, to undertake tutorial duties and research—The Secretary, The University, Edinburgh (March 1).

CHAIR OF MEDICAL PROTOZOOLOGY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 3).

PINSENT–DARWIN STUDENTSHIP IN MENTAL PATHOLOGY—The Secretary, Pinsent–Darwin Studentship, Psychological Laboratory, Cambridge (March 3).

SENIOR LECTURER IN ADVANCED NON-FERROUS METALLURGY, and a LECTURER IN MATHEMATICS—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (March 3).

EXECUTIVE ENGINEERS—MECHANICAL, MECHANICAL ENGINEERS, and MECHANICAL DRAUGHTSMEN, in the Mechanical Engineering Division of the Snowy Mountains Hydro-Electric Authority, Australia—The Engineer-in-Charge, Snowy Mountains Hydro-Electric Authority, 1–3 Regent Street, London, S.W.1 (March 4).

ASSISTANT EDUCATIONAL PSYCHOLOGIST—The County Education Officer, The Castle, Winchester (March 7).

BIOCHEMIST (with a first- or second-class honours degree in biochemistry and/or suitable research experience) IN THE DEPARTMENT OF PHYSIOLOGY, to work on mainly *in vitro* effects of pituitary and other hormones on metabolism of tissue slices—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (March 8).

LECTURER IN ASTRONOMY—The Secretary, The University, Aberdeen (March 8).

PRINCIPAL SCIENTIFIC OFFICER (with a university degree with first- or second-class honours, chemistry as a principal subject or an equivalent qualification or possessing high professional attainments) IN THE COLONIAL PRODUCTS ADVISORY BUREAU (Plant and Animal), to take charge of a section dealing with a group of products, entailing chemical and technical investigation of raw materials and the preparation of memoranda, reports and replies to inquiries regarding their production, preparation and marketing—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.393/51A (March 8).

LECTURER IN BOTANY—The Secretary, Queen's University, Belfast (March 15).

LECTURER IN DYEING AND FINISHING (with graduate, or equivalent qualifications, and a sound knowledge of dyeing and of chemistry)—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (March 15).

EXAMINERS IN THE PRINCIPLES OF BACTERIOLOGY AND IMMUNITY as applied to Veterinary State Medicine (2), Veterinary Hygiene and Preventive Medicine (1), and Food Hygiene including Meat and Milk Inspection and Control (1)—The Registrar, Royal College of Veterinary Surgeons, 9–10 Red Lion Square, London, W.C.1 (March 18).

FUEL ENGINEER in the Experimental Mobile Testing Unit of the Mechanical and Electrical Engineering Branch of Production Department—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/433 (March 22).

ASSISTANT DRAINAGE ENGINEERS in the Ministry of Agriculture and Fisheries, to deal principally with schemes in connexion with land drainage, water supply, and coast protection—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3405 (March 31).

ASSISTANT LECTURESHIPS (2) IN BOTANY, for one of which special qualifications in horticulture are required (N.D.H. or degree)—The Registrar, The University, Manchester 13 (March 31).

COLONIAL MEDICAL RESEARCH STUDENTSHIPS—The Under-Secretary of State, Colonial Office (Research Department), Sanctuary Buildings Great Smith Street, London, S.W.1 (March 31).

JOHN MURRAY TRAVELLING STUDENTSHIP IN OCEANOGRAPHY AND LIMNOLOGY—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (March 31).

LECTURER (higher salary scale) and a LECTURER (lower salary scale), IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Edinburgh (March 31).

PROFESSIONAL ENGINEERS in many Departments of the Civil Service for a wide variety of engineering duties—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London W.1, quoting S. 85/51 (March 31).

RAMSAY MEMORIAL FELLOWSHIPS for advanced students of chemistry—The Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1 (April 17).

PROFESSOR OF BOTANY in the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

SMITHSON RESEARCH FELLOWSHIP for research in natural science—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (June 15).

ANALYTICAL CHEMISTS (Experimental Officer grade) at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.78/52A/MA.

ASSISTANT PHYSICIST (degree in physics essential, and hospital experience preferred) IN THE RADIOTHERAPY CENTRE—The Secretary, War Memorial Hospital, Scunthorpe, Lincs.

BEIT MEMORIAL JUNIOR FELLOWSHIPS FOR MEDICAL RESEARCH—The Secretary, Beit Memorial Fellowships for Medical Research, Lister Institute, Chelsea Bridge Road, London, S.W.1.

BIOCHEMIST (Senior or Principal) IN THE UNIVERSITY DEPARTMENT OF HÆMATOLOGY to carry out research work in conjunction with the hæmatological and endocrinological investigations in the Department, and to supervise the work of the research workers and staff in the biochemical laboratory—The Secretary, Manchester Royal Infirmary, Manchester 13.

DESIGN ENGINEER IN THE DEPARTMENT OF RURAL WATER SUPPLY, Public Works Department, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/194.

DEVELOPMENT ENGINEERS and TECHNICAL ASSISTANTS IN THE DIVISION OF ATOMIC ENERGY (Production), Capenhurst, Chester, to participate in the work of a team engaged in the pilot plant stage of translating physical and chemical research to the plant stage—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 298.

ECOLOGIST (with a good honours degree in botany or a degree in agriculture with an interest in grassland ecology), Department of Soil and Land Use Survey, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/305.

ELECTRICAL ENGINEERS for the Central Electrification Scheme in Cyprus—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.29024.V.

ELECTRICAL ENGINEERS (Principal Scientific Officer grade) at a Ministry of Supply Research Establishment south-east of London: (*a*) (Ref. D.42/52A) to be responsible for the engineering aspects of airborne electronic equipment; (*b*) (Ref. D.43/52A) for research and development in V.H.F. and U.H.F. transmission and reception; (*c*) (Ref. D.44/52A) with experience in the design of electronic equipment; (*d*) (Ref. D.45/52A) for design and development work in a wide field of electronic instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL ENGINEERS and PHYSICISTS for work on out-of-door instrumentation at Ministry of Supply Experimental and Development Establishments near Southend and Carlisle—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.63/52A.

ENGINEER Technical Grade I (Technical Author) at a Ministry of Supply Establishment at Chessington, for the preparation of official instructional handbooks and circuit diagrams on theoretical and practical (including servicing) aspects of airborne and ground electrical equipment or on complete electrical installations in aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.376/51A.

ENGINEERS in the Directorate of Ordnance Factories/Filling, Ministry of Supply, London—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.52/52A.

EXPERIMENTAL OFFICERS (highly skilled in experimental bacteriology, biochemistry or biophysics) at a Ministry of Supply Research Establishment near Salisbury—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting G.19/52A.

INVESTIGATOR (with honours degree in chemistry or metallurgy) to study corrosion of non-ferrous metals—The Research Manager, British Non-Ferrous Metals Research Association, Euston Street, London N.W.1.

MICROANALYST IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Bristol 8.

PHYSICAL CHEMIST (Principal Scientific Officer grade) (with a first- or second-class honours degree or equivalent qualification in chemistry, and considerable research experience) with experience in reaction kinetics combining practical experience with a good theoretical physical or mathematical background, at a Ministry of Supply Research Establishment near London—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.66/52A.

PHYSICAL CHEMIST (with a good degree and some research training, which preferably should include experience in the characterization of polymers)—The Director of Research, British Rubber Producers' Research Association, 48 Tewin Road, Welwyn Garden City, Herts.

PHYSICISTS and CHEMISTS (with honours degree in physics or chemistry, associateship of the Institute of Physics or the R.I.C., or equivalent qualifications) at Capenhurst Factory, Chester, to undertake original research directed towards the design and development of an atomic energy factory and to collaborate with the engineering organizations responsible for the building and operation of the factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 297.

PRINCIPAL SCIENTIFIC OFFICER at a Ministry of Supply Research Establishment near London: PHYSICIST with knowledge of the modern theories of the structure of metals, crystals, etc., for research on the properties of metals and other materials under high rates of strain such as may be experienced in explosives ammunition, but previous experience of explosives is unnecessary—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.27/52A.

RESEARCH ENGINEER (university graduate in engineering, specializing in thermodynamics) to conduct low temperature tests of mechanical equipment in cold chambers and to supervise operations of 1,000 h.p. ammonia refrigeration plant—The Employment Officer, National Research Council, Sussex Street, Ottawa, Canada (apply by airmail).

SCIENTIFIC ASSISTANT with ability to abstract in concise English, technical (horticultural) literature published in both English and several foreign languages—The Commonwealth Bureau of Horticulture and Plantation Crops, East Malling, Maidstone, Kent.

SENIOR SCIENTIFIC OFFICER at Ministry of Supply London headquarters (duties include the interpretation of Service requirements for fuses for aircraft bombs, and the initiation and co-ordination of associated research and development work)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.21/52A.

SENIOR SCIENTIFIC OFFICER IN THE ORGANIC CHEMISTRY LABORATORY, to join a team of physical and organic chemists engaged on investigations related to the constitution of coal—The Assistant Secretary (Ref. A.6), British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey.

TECHNICAL AUTHORS (Engineer III Grade or Technical Grade I) at Ministry of Supply Establishments at Chessington, Malvern and Farnborough, for the preparation of official instructional publications on the theoretical and practical (including servicing) aspects of airborne and ground centimetric radar or radio communications equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.375/51A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Iron and Steel Institute. Preprints of Papers for the Symposium on the Corrosion of Buried Metals, 12th December, 1951. Pp. ii+110. (London: Iron and Steel Institute, 1951.) [312

Scientific Proceedings of the Royal Dublin Society. Vol. 25 (N.S.), No. 21: Indole Metabolism, 1, The Colorimetric Estimation of Indole by the Xanthydrol Reaction. By William Robert Fearon and James Antony Drum. Pp. 295–298. 6*d*. Vol. 25 (N.S.), No. 22: Studies in Indole Metabolism, 2, The Estimation of Indoxyl. By James Antony Drum. Pp. 299–304. 1*s*. (Dublin: Royal Dublin Society, 1951.) [312

British Gelatine and Glue Research Association. Third Annual Report for the Year October 1950 to September 1951. Pp. 13. (London: British Gelatine and Glue Research Association, 1951.) [312

Anti-Locust Bulletin 10: Observations on the Moroccan Locust (*Dociostaurus maroccanus* Thunberg) in Cyprus, 1950; 1. Cyprus Locust Research Scheme, by Dr. B. P. Uvarov; 2. Vegetation of Locust Habitats, by E. Chapman; 3. Observations on Locust Hoppers, by Dr. N. Waloff; 4. Observations on Adult Locusts, by A. R. Waterston. Pp. iv+54+5 plates. (London: Anti-Locust Research Centre, British Museum (Natural History), 1951.) [512

Buyers' Guide of Chemicals, Chemical Plant, Laboratory Equipment and Apparatus. (Supplement to *Chemistry and Industry*.) Pp. 8. 12*s*. (London: Society of Chemical Industry, 1951.) [512

Department of Scientific and Industrial Research and Fire Offices' Committee: Fire Research. Technical Paper No. 1: The Fire Hazard of Fuelling Aircraft in the Open. By Dr. L. L. Katan. Pp. iv+16. (London: H.M. Stationery Office, 1951.) 1*s*. net. [512

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 11: Binder Distributors for Surface Dressing. By D. B. Waters and W. L. Russell. Pp. 16+8 plates. (London: H.M. Stationery Office, 1951.) 1*s*. 6*d*. net. [612

Edinburgh and East of Scotland College of Agriculture. Technical Bulletin No. 4: The Influence of Man and Animals on the Vegetation of certain Hill Grazings in South East Scotland, 1. By Dr. E. Wyllie Fenton. Pp. 62. (Edinburgh: Edinburgh and East of Scotland College of Agriculture, 1951.) [612

Other Countries

First Seminar for European Sanitary Engineers, The Hague, 27 November to 2 December 1950. Pp. vi+244. (Geneva: World Health Organization, 1951.) [512

World Health Organization. Technical Report Series No. 43: Expert Committee on the International Pharmacopœia; Report on the Eighth Session, including Report on the Second Session of the Subcommittee on Non-Proprietary Names. Pp. 36. (Geneva: World Health Organization: London: H.M. Stationery Office, 1951.) 2*s*.; 25 cents; 1 Swiss fr. [512

New Zealand: National Art Gallery and Dominion Museum. Report of the Board of Trustees for the Year ended 31st March, 1951. Pp. 17. (Wellington: Government Printer, 1951.) [512

Indian Forest Records (New Series). Botany, Vol. 4, No. 1: Contributions to our Knowledge of the Morphology, Cytology and Biology of Indian Coniferous Rusts, Part 2, Observations on the Occurrence of *Cronartium ribicola* Fischer and *Peridermium indicum* Colley and Taylor on *Pinus excelsa* Wall. in India with reference to their Distribution, Pathology, Inoculation Experiments and Comparative Morphology. By Dr. K. D. Bagchee. Pp. iii+42+13 plates. 3.12 rupees; 6*s*. Botany, Vol. 4, No. 2: Contributions to our Knowledge of the Morphology, Cytology and Biology of Indian Coniferous Rusts, Part 3, The Biology of *Peridermium brevius* (Barc.) Sacc. (*Coleosporium barclayense* sp. nov. on *Senecio rufinervis* DC.), and *Melampsora oblonga* sp. nov. on the Needles of *Pinus excelsa* Wall. By Dr. K. D. Bagchee. Pp. iii+43–64+7 plates. 3.10 rupees; 5*s*. 9*d*. (New Delhi: Manager of Publications, 1950.) [612

Smithsonian Miscellaneous Collections. Vol. 117, No. 4: A Revised Classification for the Birds of the World. By Alexander Wetmore. (Publication 4057.) Pp. ii+22. (Washington, D.C.: Smithsonian Institution, 1951.) [1012

United Nations: Department of Social Affairs. The Impact of the Universal Declaration of Human Rights. Pp. iv+42. (New York: United Nations; London: H.M. Stationery Office, 1951.) 25 cents; 1*s*. 9*d*.; 1 Swiss franc. [1012